

File Copy

WISCONSIN DEPARTMENT OF NATURAL RESOURCES
DIVISION OF FORESTRY, WILDLIFE AND RECREATION

BUREAU OF FISH AND WILDLIFE MANAGEMENT
Fish Management Section Report Number 69

June, 1974

The Effects of A Commercial Gill Net Fishery on The Fish and Waterfowl of Pool 7, Mississippi River

Richard G. Ranthum
Mississippi River Fisheries Biologist

WEST CENTRAL DISTRICT

93

107

The Effects of A. ... on
The Fish and Wildlife of the Mississippi River

Mississippi River Wildlife Project

Wisconsin Department of Natural Resources
Box 450
Madison, Wisconsin 53701

THE EFFECTS OF A COMMERCIAL GILL NET FISHERY ON THE
FISH AND WATERFOWL OF POOL 7, MISSISSIPPI RIVER

Project Completion Report

Project No. 3-133-R "Status of Fish Populations
in Pool 7 of the Mississippi River and Probable
Effect of Commercial Gill net Fishery"

Funded under Commercial Fisheries Research and
Development Act.

TABLE OF CONTENTS

	<u>Page</u>
Introduction	1
Methods	3
Results	5
Fishing Effort	5
Effort by Month	5
Effort by Location	7
Summary of Effort Distribution	7
Catch	8
Catch by Location	13
Catch by Month	17
Size Distribution of Fish Taken in Gill Nets	22
Efficiency	34
Efficiency by Month	40
Efficiency by Area	47
Effect of Mesh Size on Efficiency of Gill Nets for Fish and Ducks	51
Mortality of Non-Commercial Fish and Waterfowl	53
Seasonal Aspects of Mortality	56
Mortality by Location	57
Non-Commercial Fish Mortality and Time Length of Set	57
Economic Value of the Commercial Catch	59
Value by Month	60
Value by Location	62
Comparisons Between the Commercial Catch & Non-Commercial Catch	63
Commercial Catch Rate per Non-Commercial Fish & Waterfowl	63
Commercial Value Rate per Non-Commercial Fish & Waterfowl	69
Comparisons Between Commercial and Non-Commercial Catch Values	69
Summary	78
Discussion and Conclusions	85
Acknowledgements	89

INTRODUCTION

Pool 7 includes an 11 mile section of the Mississippi River covering 13,600 acres between Lock and Dam 6 at Trempealeau, Wisconsin and Lock and Dam 7 near Dresbach, Minnesota (Figure 1). This area provides a considerable commercial fishery (averaging about one-half million pounds annually), a large sport fishery ($\frac{1}{4}$ million sport fish weighing $\frac{1}{6}$ million pounds caught annually), and waterfowl hunting (about 9,000 ducks bagged annually).

Most of Pool 7, except the main channel and bordering areas, was closed to commercial gill netting in May of 1964 due to concern about the damage gill nets allegedly caused to game fish and ducks.

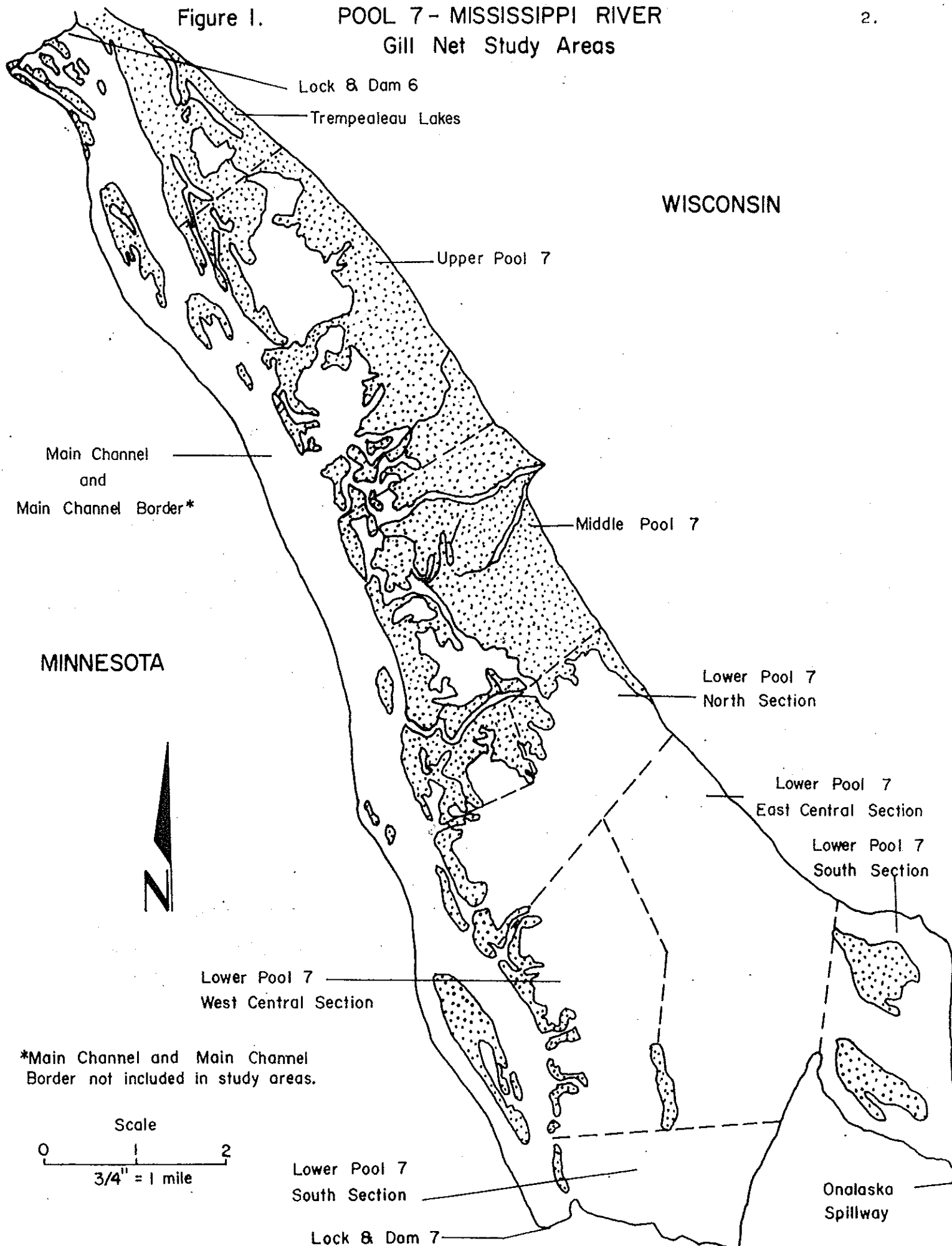
Most of the closed area is classified as river lake habitat, with smaller amounts of side channel, chute, and slough habitats.

The closure was followed by a considerable change in the nature of the Pool 7 commercial fishery. Prior to 1964, gill nets were the dominant gear in the fishery, accounting for over one-half the average annual catch. Seines generally produced less than one-tenth of the commercial harvest up to five years before the gill netting closure, and increased in importance about one-fourth of the catch in the five years immediately prior to closure. Gill net catches declined drastically in importance after 1964, averaging only about one-eighth of the commercial catch over a five year period following the closure. However, seining showed a corresponding increase, producing two-thirds of the commercial catch during this period. As a result, the average total commercial catch for the five years after closure was almost identical to that for the five years prior to closure and up one-fifth from the 10-year average prior to 1964.

Figure 1.

POOL 7 - MISSISSIPPI RIVER
Gill Net Study Areas

2.



The closed area was re-opened to gill netting under special contracts in May, 1970 so that the magnitude of sport fish and waterfowl catches could be accurately assessed through a detailed study of the gill net fishery. The Department of Natural Resources began collecting data in September, 1970 through its own netting program to complement the information from contract netting. Collection of field data was terminated at the end of April, 1972.

METHODS

Contract fishing operations were closely observed by Department personnel who accompanied commercial fishermen as frequently as possible when fish were being removed from contract gill nets. Eighty percent of the contract gill net fishing was monitored in this manner. Data were collected on the size and numbers of commercial fish taken in the nets. In addition, contract fishermen were required to supply daily reports on the poundage and value of the saleable catch. The number, size, and condition of all game fish found in the nets were recorded. Records were also kept of the number and condition of ducks caught. Additional data collected were the number of feet of gill net fished, the mesh size, the date and duration of the set, and the location in the pool.

Collection of these data enabled analysis of the statistical parameters of the gill net fishery with respect to two important influencing variables; 1) time of year (by month); and 2) geographical location (map areas in Figure 1).

Commercial fishermen frequently concentrate their efforts in specific areas where sufficient numbers of commercial fish have been located. Different commercial fish species often are found in different areas, and the location of nets is therefore related to the species being sought. Buffalo are more valuable and less damaging to nets than carp and are therefore the preferred target species of gill netters when adequate numbers can be located. Carp are found more commonly in large concentrations than buffalo and are often fished instead of buffalo despite their lower value, particularly when buffalo are difficult to catch. Strong currents resulting from high water or wind carry debris into gill nets, considerably lowering their effectiveness and requiring a tedious and lengthy cleaning process. Therefore, weather conditions can also influence the amount of fishing and when and where nets are set. These characteristics of the gill net fishery tend to provide data from only limited areas for a given period when the number of fishermen is small, as was the case under contract conditions. Also, there was a possibility that while their operations were being observed, commercial fishermen might be more reluctant to fish when and where they felt game fish and ducks were likely to be taken than they would otherwise.

To avoid bias and obtain information not available from contract fishing, Department nets of the same type as those fished commercially were set and moved to cover as many different study areas as were fishable until all of Pool 7 had been sampled in a minimum amount of time. Areas already being fished under contract at a given time were avoided to prevent duplication of effort. All the catch data recorded for contract nets were also taken for Department nets by mesh size.

RESULTS

The results of this study are presented by analyzing three major statistical parameters:

1. Fishing effort - the amount of net fished;
2. Catch - the fish and waterfowl taken, and;
3. Efficiency - the catch per unit of gear fished.

Fishing Effort

Just over one-million feet of gill net were fished during the study period, May, 1970 through April, 1972 under contract and by Department personnel (Table 1). Contract fishing accounted for almost 90 percent of the effort. The study was divided into two 12-month periods to evaluate the fishery in annual terms: 1) May, 1970 through April, 1971; and 2) May, 1971 through April, 1972. Contract effort was somewhat higher (56 percent of the total) during the first period. Department netting was heavier during the second period, just over 60 percent of the total. This was largely due to the fact that no Department nets were available during the first four months of the study and that the second period included three months of winter netting under the ice.

Effort by Month

Seasonally, contract fishing effort generally ranged between 40,000 and 60,000 feet per month. Exceptionally high effort occurred during July, September, and October, 1970. Months of lowest effort were May, 1970 and November, 1971. Monthly effort with Department nets can be roughly divided into three groups: high levels in September and October, 1970, and April, June and September, 1971; moderate effort in May, July, and October, 1971; and low effort in November, 1970, August and November, 1971, and January through April, 1972.

Table 1

FISH EFFORT (FEET OF NET FISHED)
UNDER CONTRACT AND BY THE DEPARTMENT
May 1970 - April 1972

	1970-71	1971-72	Combined
Contract	503,800	398,100	901,900
Department	41,500	66,500	108,150
TOTAL	545,300	464,600	1,010,050

Effort by Location

The distribution of fishing effort by location within the study area was also examined. During the 1970-71 period, contract effort was concentrated in the central section of the lower pool, with equal amounts fished in both the east and west divisions. The north and south sections ranked next. Effort was lowest in the upper and middle sections of the pool. Fishing patterns changed somewhat in 1971-72, when effort in the north section of the lower pool increased to dominate that in all other areas. Substantial declines occurred in the east and west central, south, and middle pool areas, while the upper pool showed a considerable increase. Department netting in 1970-71 was heaviest in the upper and middle pool areas. The west central section received the most effort in the lower pool, with the north and east central areas intermediate, and the south area lowest. Increased department netting in the 1971-72 period brought increases in the amount of net fished in all areas except the upper pool, which declined nearly 50 percent. Effort was highest in the middle pool area, followed by the east and west central sections and the north section. South and upper pool areas were fished least.

Summary of Effort Distribution

Contract fishing in the upper pool occurred only in the spring months of April and May, thus accounting for the relatively low amount of effort in this area. Fishing in the middle pool took place in late summer and fall. The north section was fished during late summer and fall 1970-71, but during the entire period in 1971-72, accounting for the effort increase there. The west central area was fished over the entire season and the east central during all except the early and late part of the season during both years.

Most of the fishing in the west central section took place in late summer and fall, while in the east central area mid-summer was more important. In the south section, fishing occurred in all months except April, mainly in mid- and late summer.

Catch

A total catch of 330,000 pounds of commercial fish was taken during the study period, 96 percent by contract fishing (Table 2). In addition, 321 non-commercial fish weighing 1,646 pounds and 66 ducks were also caught (Tables 3 and 4). Contract fishing accounted for 75 percent of the number of non-commercial fish and 70 percent of their weight. Approximately 85 percent of the ducks were caught in contract nets.

The dominant commercial species was carp, accounting for 86 percent of the commercial contract catch by weight. Buffalo ranked second at 10 percent, followed by drum, considerably less important at just under 1.5 percent of the catch. Flathead and channel catfish were the only other species of significance, together making just over 1 percent of the catch. The flathead catfish catch exceeded the channel catfish catch 9 to 1 by weight. Other commercial species of lesser importance in the catch included redhorse, carpsuckers, gar, bowfin, and softshell and snapping turtles.

The composition of the Department net commercial catch was similar to the contract catch except that carp made up a slightly smaller fraction of the total (81 percent) while the other species were all more significant.

Table 2

CATCH (POUNDS) OF MAJOR COMMERCIAL SPECIES IN CONTRACT AND DEPARTMENT NETS, MAY 1970* - APRIL 1972

	CARP	BUFFALO	DRUM	FLATHEAD CATFISH	CHANNEL CATFISH	TOTAL CATFISH	TOTAL ALL SPECIES
Contract Nets 1970-71	156,438	16,513	2,223	1,901	223	2,124	177,298
1971-72	117,035	15,756	1,862	1,330	197	1,527	136,180
1970-72 Combined	273,473	32,269	4,085	3,231	420	3,651	313,478
Department Nets 1970-71	5,118	711	86	62	16	78	5,993
1971-72	9,638	1,576	274	229	35	264	11,752
1970-72 Combined	14,756	2,287	360	291	51	342	17,745
1970-71 Contract and Department Combined	161,556	17,224	2,309	1,963	239	2,202	183,291
1971-72 Contract and Department Combined	126,673	17,332	2,136	1,559	232	1,791	147,932
GRAND TOTAL Contract and Department Nets	288,229	34,556	4,445	3,522	471	3,993	331,223

* Department netting began in September 1970. The only netting under the ice during the study was done January through March 1972 with Department nets only.

Table 3

CATCH (NUMBER AND POUNDS) OF NON-COMMERCIAL FISH IN CONTRACT AND DEPARTMENT NETS
MAY 1970 - APRIL 1972

SPECIES	CONTRACT NETS						DEPARTMENT NETS						Grand Total	
	1970-71		1971-72		Combined		1970-71		1971-72		Combined			
	#	lbs.	#	lbs.	#	lbs.	#	lbs.	#	lbs.	#	lbs.		
Northern Pike	95	606	52	308	147	914	19	121	38	314	57	436	204	1,350
Walleye	7	31	9	36	16	67	1	8	3	10	4	18	20	85
Sauger	10	9	2	2	12	11	-	-	-	-	-	-	12	11
Largemouth Bass	5	21	1	6	6	27	-	-	-	-	-	-	6	27
Total Large Game Fish	117	667	64	352	181	1,019	20	129	41	324	61	454	242	1,473
Crappie	12	8	5	4	17	12	-	-	4	2	4	2	21	14
Bullhead	2	2	2	2	4	4	-	-	1	1	1	1	5	5
White Bass	1	1	2	3	3	4	1	1	-	-	1	1	4	5
Bluegill	-	-	1	0.5	1	0.5	-	-	1	0.5	1	0.5	2	1
Rock Bass	-	-	-	-	-	-	-	-	1	0.5	1	0.5	1	0.5
Total Panfish	15	11	10	9.5	25	20.5	1	1	7	4	8	5	33	25.5
Sublegal Catfish	21	35	11	20	32	55	2	4	7	16	9	20	41	75
Paddlefish	3	44	1	9	4	53	-	-	-	-	-	-	4	53
Rock Sturgeon	-	-	-	-	-	-	-	-	1	20	1	20	1	20
Total Other Species	24	79	12	29	36	108	2	4	8	36	10	40	46	148
GRAND TOTAL ALL SPECIES	156	757	86	390.5	242	1,147.5	23	134	56	364	79	499	321	1,646.5

Table 4

NUMBER OF WATERFOWL TAKEN IN CONTRACT AND DEPARTMENT NETS DURING
OCTOBER-NOVEMBER 1970, 1971 AND APRIL 1971, 1972

FALL							
SPECIES	CONTRACT NETS			DEPARTMENT NETS			Grand Total
	1970	1971	Combined	1970	1971	Combined	
Scaup	10	29	39	9	-	9	48
Canvasback	11	-	11	-	-	-	11
Scoter	1	-	1	-	-	-	1
Bufflehead	1	-	1	-	-	-	1
Merganser	-	1	1	-	-	-	1
Coot	1	-	1	-	-	-	1
TOTAL	24	30	54	9	0	9	63

SPRING							
SPECIES	CONTRACT NETS			DEPARTMENT NETS			Grand Total
	1971	1972	Combined	1971	1972	Combined	
Scaup	-	2	2	1	-	1	3

SPRING AND FALL COMBINED							
SPECIES	CONTRACT NETS			DEPARTMENT NETS			Grand Total
	1970-71	1971-72	Combined	1970-71	1971-72	Combined	
Scaup	10	31	41	10	-	10	51
Canvasback	11	-	11	-	-	-	11
Scoter	1	-	1	-	-	-	1
Bufflehead	1	-	1	-	-	-	1
Merganser	-	1	1	-	-	-	1
Coot	1	-	1	-	-	-	1
TOTAL	24	32	56	10	-	10	66

The dominant non-commercial fish was the northern pike, with 204 fish weighing 1,350 pounds, making up two-thirds of the non-commercial catch by number and 80 percent by weight. Of the three remaining game fish species, walleyes were next in significance. A few large largemouth bass accounted for most of the remaining weight of game fish taken, and saugers most of the remaining numbers. Taken as a group, game fish made up 75 percent of the number and almost 90 percent of the weight of non-commercial fish. Crappies were the only panfish taken in appreciable numbers. All panfish together accounted for 10 percent of the numbers and 1.5 percent of the weight of non-commercial fish. Sublegal channel catfish (under 20 inches in length) comprised the bulk of the other non-commercial fish. They ranked on a par with the panfish in numbers and walleyes in weight. Combined with a few large paddlefish and sturgeon, they made up 9 percent of the weight of the non-commercial catch.

The most common waterfowl in the gill nets were scaup, comprising over three-fourths of the ducks taken. Canvasbacks were the only other duck of significance making up about one-fifth of the total. No dabbling ducks or geese were encountered in the nets, although they were present in the areas fished.

To determine if the incidental catch of non-commercial fish and ducks in gill nets might be concentrated in problem areas and/or times of the year, catch data were examined by location and month. The significance of both the commercial and non-commercial catches at certain times and in particular areas could then be compared and evaluated.

Catch by Location

The west central section of lower Pool 7 was the area producing the largest part of the 1970-71 commercial catch, over one-third.

The east central section ranked next, and together they accounted for over one-half of the total. Of the remaining four areas, the south section ranked highest with 14 percent of the catch and the middle pool lowest with 8 percent.

The proportion of the non-commercial fish caught in the west central section was very similar to the commercial catch distribution, with nearly one-third of the non-commercial and game fish taken there, and just over one-third of the northern pike.

The north and upper pool each produced nearly one-fifth of the gamefish and northern pike, and a slightly lower proportion of all non-commercial fish. The south section had the lowest northern pike catch, but the highest catch of other game fish and sub-legal catfish. The largest number of panfish came from the east central area, as did a large part of the sublegal catfish.

Considering the major commercial species, the west central area produced 40 percent of the total carp catch, followed by the east central with half that amount. The remaining areas ranged from 12 percent for the north section to 9 percent for the upper and middle pool sections. The buffalo catch showed a considerably different distribution than carp, with the south section most significant (35 percent) followed closely by the east central (30 percent).

The upper, north, and west central pool areas were quite similar, ranging from 11 to 13 percent. The buffalo catch from the middle pool was insignificant. The east central area was the leading drum producer with 40 percent followed by 30 percent from the south section, and 16 percent from the west central area.

The northern areas of Pool 7 produced the smallest drum catches. Nearly all the catfish came from the south area (45 percent) and the east central area (40 percent). The west central and north areas were low and the upper and middle pool areas insignificant.

Two-thirds of the ducks taken in contract nets during the fall of 1970 came from the north section, including 30 percent of the scaup and 10 of 11 canvasbacks. The upper and middle pool sections were not fished during this time. Contract nets in the spring of 1971 caught no ducks.

The distribution of the contract catch in the second year of the study changed considerably. The north section was the area of largest commercial catch, increasing to 40 percent of the total from 11 percent the first year. The west central area dropped to second place, with just under one-fourth of the catch. The upper pool showed a marked increase from 9 to 20 percent of the catch. The south, east central, and middle pool areas all showed substantial declines in importance.

In general, the distribution of non-commercial fish was again similar to that of the commercial species. The north section had the largest number of non-commercial fish, just over one-third, followed by the upper pool with just over one-fourth. Each of the two sections accounted for one-third of the northern pike taken. The west central section ranked third, with just under one-fourth of the non-commercial fish and just over one-fourth of the northern pike. The remaining three areas produced only 16 percent of the non-commercial fish.

The area with the largest carp catch (again 40 percent of the total) changed from the west central area in 1970-71 to the north section in 1971-72. The catch in the west central area declined to 25 percent, while the upper pool increased to 20 percent. The remaining three areas each accounted for under 10 percent of the second year catch, substantial declines from 1970-71 levels.

The buffalo catch also showed a major change in distribution the second year. The north and upper pool areas which had intermediate catches the first year increased to exchange positions with the south and east central areas which declined from their leading role in 1970-71. The catch levels in the west central and middle pool areas also dropped the second year, together accounting for less than 10 percent of the 1971-72 buffalo catch.

The leading drum producing area changed from the east central to the north section, with an increase from 40 to 50 percent of the catch. The two central areas contributed another 30 percent, 18 percent from the east central and 12 percent from the west central. Both east central and south areas experienced sharp catch drops, while the west central and middle pool areas showed smaller declines from 1970-71 levels. The upper pool increased in significance, but like the middle and south areas, contributed under 10 percent of the second year total.

The dominant area for catfish moved from the south to the north section and increased to nearly one-half the total catch in 1971-72. The east central area decreased to one-half its 1970-71 significance, but retained second place, with 18 percent. The upper pool showed a sharp increase to a level just below that of the east central section.

The south section declined drastically to one-fourth its importance in 1970-71, to a level on a par with the west central area, which contributed 9 percent of the annual catch each year. The middle pool remained insignificant.

The 1971-72 waterfowl catch came almost entirely from the north section where 29 scaup were taken in one 600 foot span of net set during November. One merganser was the only other duck taken during the fall migration. The spring migration produced two scaup from the upper pool section in April.

In summary, all areas of Pool 7 except the middle pool contributed significantly to the commercial catch. The west central area was the only one of considerable importance both years; the east central and south sections ranked high in one year and the upper and north in the other.

The non-commercial catch involved the same areas as the commercial one, with a general shift from the central and south sections the first year to the upper and north sections the second. The game fish portion of the non-commercial catch was centered in three areas both years; the upper, north and west central. The upper and north section produced the same number of gamefish each year, while the west central exceeded these areas the first year and dropped below them the second. The carp catch was taken mainly from the east and west central, north, and upper sections of the pool. The west central area was the most consistent producer, with the east central important the first year and the upper and north sections the next. The east central and south sections contributed considerably to the buffalo catch in both years, but the north and upper sections exceeded them the second year. The drum catch came most consistently from the east central section, with the south section also important the first year and the north section the second year.

The catfish catch had a similar distribution to that of the drum, with an additional contribution from the upper pool the second year. Fall migration waterfowl catches came chiefly from the north section and spring migration ducks from the upper pool only.

Catch by Month

Contract fishing was done during 8 of the 12 months in each year of the study, with no fishing during the period of ice cover, December--March. If the catch were equally distributed throughout the fishing season, each month would produce about 12 percent of the catch, which furnishes a convenient standard for evaluating the actual seasonal catch distribution. During the first year of the study, November led with 18 percent of the commercial catch, followed closely by September and April. July was slightly above average and June and October slightly below. The months of lowest catch were August and May, 7 percent each. The pattern changed considerably in the second year of the study, with an April catch of 25 percent dominating. November, which led the 1970-71 monthly catches, declined to the lowest month in 1971-72, 5 percent. May and June both rose to above-average status, while the remaining months, July - October, were below average. This involved a decline in the importance of July and September, an increase in August, and no change in October. In summary, only April was a consistently high commercial fish producer over both years. August and October were below average both years. Five months were above average one year and below average the other. May, September, and November varied widely from the mean, and June and July to a lesser degree.

Three out of the four months with above average commercial catches the first year produced above-average non-commercial catches (Figure 12). April led with 24 percent of the non-commercial catch, with September and November accounting for 15 percent each. October, slightly below average in commercial harvest, ranked with the other fall months in non-commercial catch (16 percent). Both June and July contributed more significantly to the commercial harvest than to the non-commercial catch. May and August ranked low in both commercial and non-commercial catches.

In 1971-72, two of three above-average commercial catch months also had above-average non-commercial catches; May (26 percent) and April (19 percent). The third month, June, accounted for the second lowest non-commercial catch. July and September both contributed an above-average portion of the non-commercial catch and a below-average part of the commercial catch. August, October, and November were below average to a similar extent for both commercial and non-commercial catches.

In summary, two months had consistently above-average non-commercial catches during both years, April and September, while two were consistently low, June and August. May, October, and November varied widely above and below the mean, and July to a lesser extent. Commercial and non-commercial catches were above or below average simultaneously in over half the months of the study.

Fall and spring months accounted for over half the gamefish portion of the non-commercial catch both years. April again was the most consistently high month, with 30 percent the non-commercial catch the first year and 22 percent the second. October and November were above average months the first year (21 and 19 percent, respectively), and May the second year (30 percent). All other months ranged from average to well below.

The monthly distribution of the commercial catch by species was examined. Seasonal trends in the carp catch closely resemble those of the total commercial catch already discussed. The buffalo catch was generally above average the first four months of the fishing season, April through July. April varied most between the two years (12 to 30 percent), with May through July between 15 and 21 percent both years. August (8 to 9 percent) and November (0.3 to 0.6 percent) were quite constant between years, while September (15 to 5 percent) and October (10 to 3 percent) were more variable.

Drum catches were consistently above average during the summer months (June through August). July 1970 had the highest monthly catch (36 percent) with all other summer months between 15 and 21 percent. Transitional months of May and September ranged from near to below average. April and October were consistently below average both years and November produced no drum either year.

Flathead catfish catches were highest in late spring and summer, May through September. July was the peak month both years with 26 to 27 percent of the annual catch. The remaining four months ranged from 12 to 21 percent. October and April were low months (1 to 7 percent), and November produced no flathead catfish either year. Channel catfish catches showed a different seasonal distribution for the two study years. The first year May was the leading month with 30 percent of the catch, with June and October following at 17 percent. August, September, and April were average to slightly below, and July was low. In 1971-72, April accounted for 77 percent of the catch, with all other months low. November produced no channel catfish either year.

In summary, the months of above-average commercial catch varied considerably between the two years of the study. April was the only month of above-average catch both years. Months of high catch in one year only were November, September, May, June, and July. August and October were below average both years, while May and November each were exceptionally low catch months in one of the two years.

The non-commercial catch was above-average in April and September both years. The first year October and November also had a high non-commercial catch, and the second year May and July were above-average. June and August were below average in non-commercial catch both years, while May and July were low the first year and October and November the second. Three of the eight months had higher percentages for commercial fish than non-commercial fish during both years: June, August, and November. May was the only month where the non-commercial catch percentage was higher than the commercial one both years. All the remaining four months had a higher commercial catch percentage one year and a higher non-commercial percentage the second.

Only April had above-average gamefish catches both years. Months with high gamefish percentages for one year only were May, October, and November. June, July, and August took below-average numbers of gamefish both years. September was average one year and slightly below the other.

Above-average carp catches occurred in both Aprils, and below-average ones in both Augusts and Octobers. High carp catches for one year only occurred in November, September, May, and June. The buffalo catch was above average May through July and below average August, October, and November during both years. High buffalo catches were made in one April and one September.

The period June through August brought above-average drum catches and April-May and October-November below average drum catches during both years. September was above average the first year and below average the second. Catfish catches ran high May through July and low in October-November both years. August had an above-average catch one year and average the other, and September above-average one year and below-average the next. The largest carp catches were made in early spring and late fall. Good catches did occur from late spring through late summer, but not consistently over both years. The occurrence of low catches varied, but most consistently appeared in late summer and early fall. Most of the buffalo and catfish catch was made between late spring and mid-summer, and drum from early to late summer. Large catches of buffalo and catfish were made in early spring also, but not during both years. No large drum catches were made in early spring, and buffalo catches were generally lowest in late summer. Fall brought low catches of buffalo, drum, and catfish.

Department net catches are not of particular significance as such, since the amount of effort and its timing and location is not related to commercial activity. However, these data are useful when converted to a catch per unit effort or efficiency statistic, giving the rate at which fish or waterfowl can be expected to be taken in a particular area or during a certain time period. This statistic can also be usefully applied to the commercial contract effort and catch previously discussed, since the study indicated that amount of commercial effort and its distribution by location and month can also be expected to vary between years.

Size Distribution of Fish Taken in Gill Nets

Length frequencies were plotted from samples of the lengths of commercial fish taken in contract nets. Lengths of all non-commercial fish taken in contract nets monitored by Department personnel were also examined. Length frequencies for Department nets included all fish taken.

Carp taken in contract nets ranged from 15 to 39 inches in length, with those between 23 and 30 inches most significant (Figure 2). The 27-inch size group contained the largest number of carp measured. Buffalo ranged from 18 to 43 inches in length, with those from 20 to 28 inches most common (Figure 3). The 23-inch size group held the largest number of fish measured. The drum measured ranged from 8 to 30 inches in length, with most between 13 and 25 inches (Figure 4). There were two distinct peaks in the size distribution, one between 14 and 16 inches and the second between 21 to 23 inches. Flathead catfish ranged from 12 through 42 inches, with most between 26 and 30 inches (Figure 5). The 27-inch group contained the largest number of fish. Channel catfish ranged from 12 through 29 inches in length (Figure 6). Most were between 14 and 26 inches, with a peak at the 20 and 21-inch groups.

Northern pike taken in contract nets ranged from 12 to 42 inches, with most from 18 to 28 inches (Figure 7). The 19 and 20 inch and the 27 and 28 inch size groups contained the largest numbers of fish. Walleyes ranged from 11 to 29 inches, sauger from 11 to 17 inches, and largemouth bass from 12 through 20 inches. The numbers of walleye, sauger and largemouth bass were too small to establish any particular size significance. The panfish taken ranged from 8 to 16 inches, with those 9 to 12 inches most numerous (Figure 8). Most sublegal catfish were between 16 and 18 inches (Figure 9). Paddlefish ranged from 36 to 43 inches.

Figure 2. Length Frequency of Carp Taken in Contract and Department Nets.

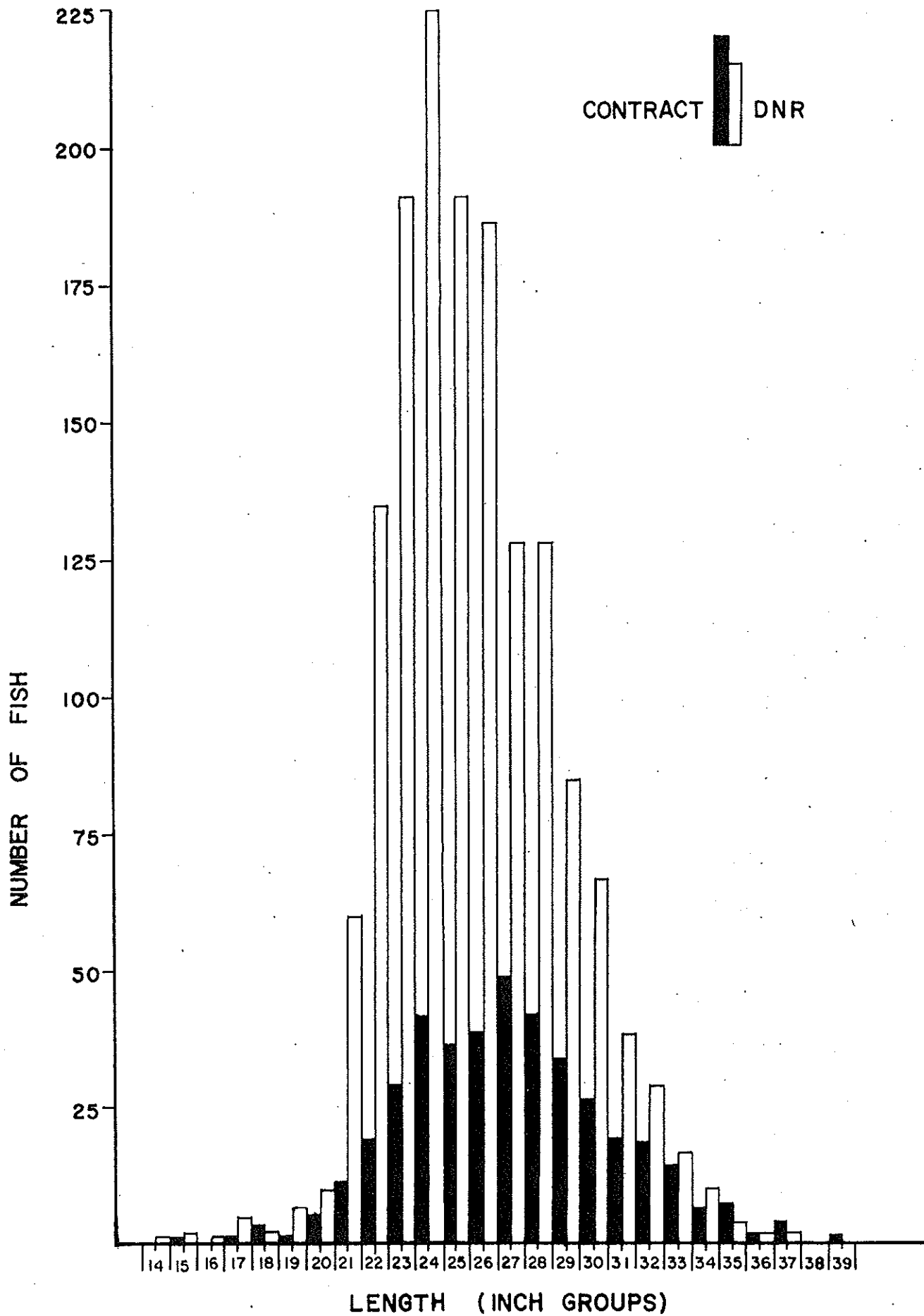


Figure 3. Length Frequency of Buffalo Taken in Contract and Department Nets.

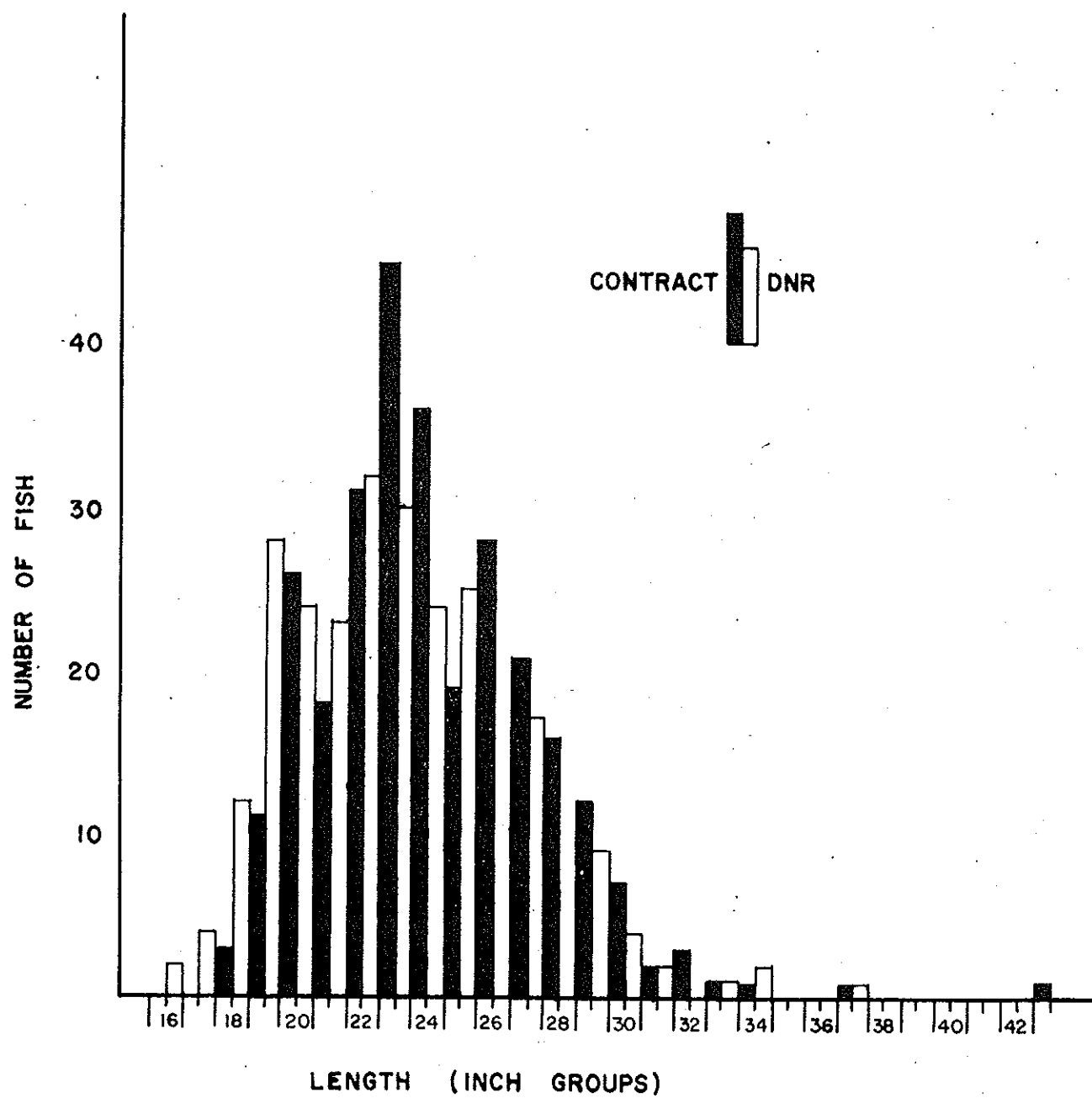


Figure 4. Length Frequency of Freshwater Drum Taken in Contract and Department Nets.

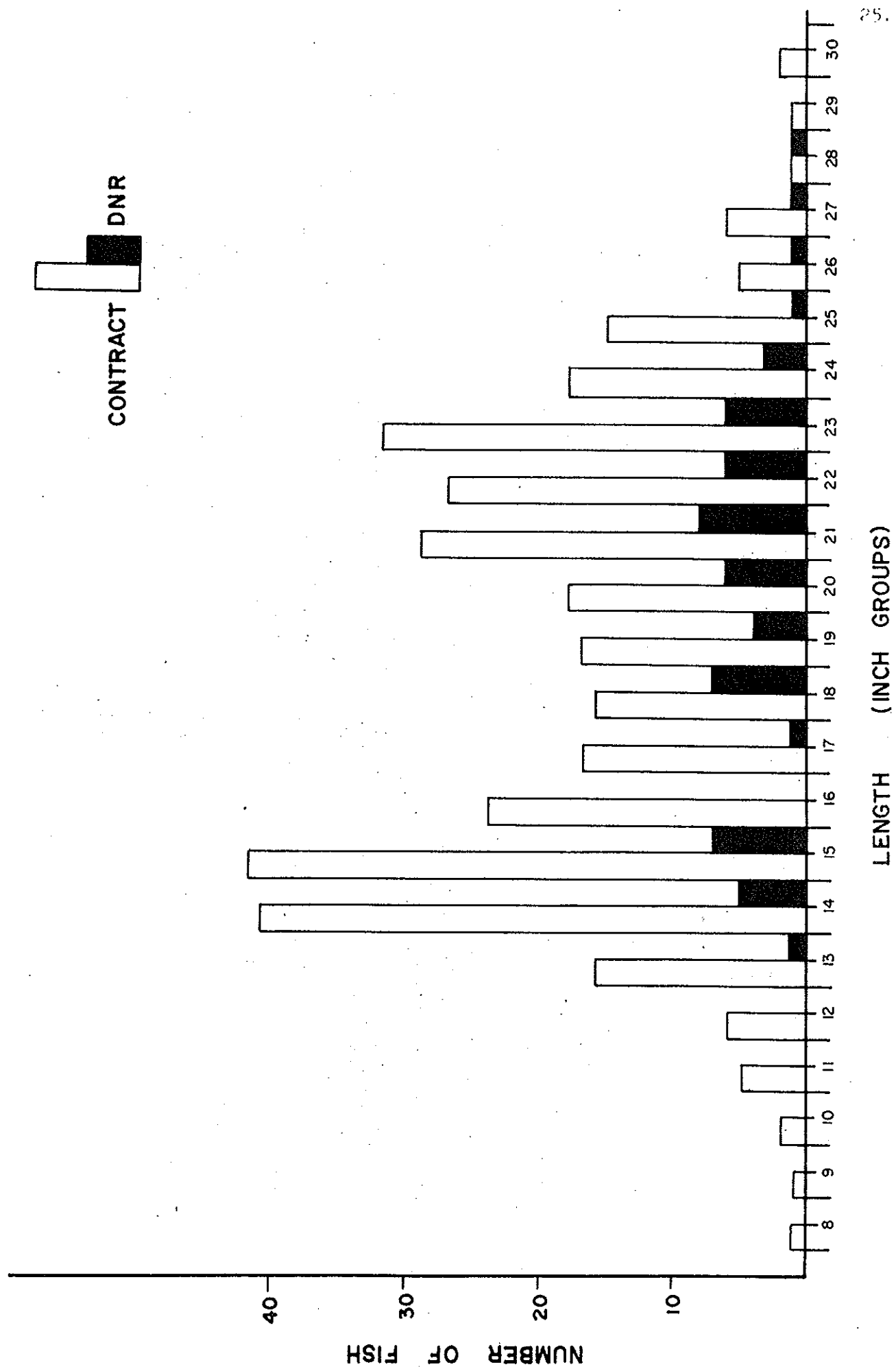


Figure 5. Length Frequency of Flathead Catfish Taken in Contract and Department Nets.

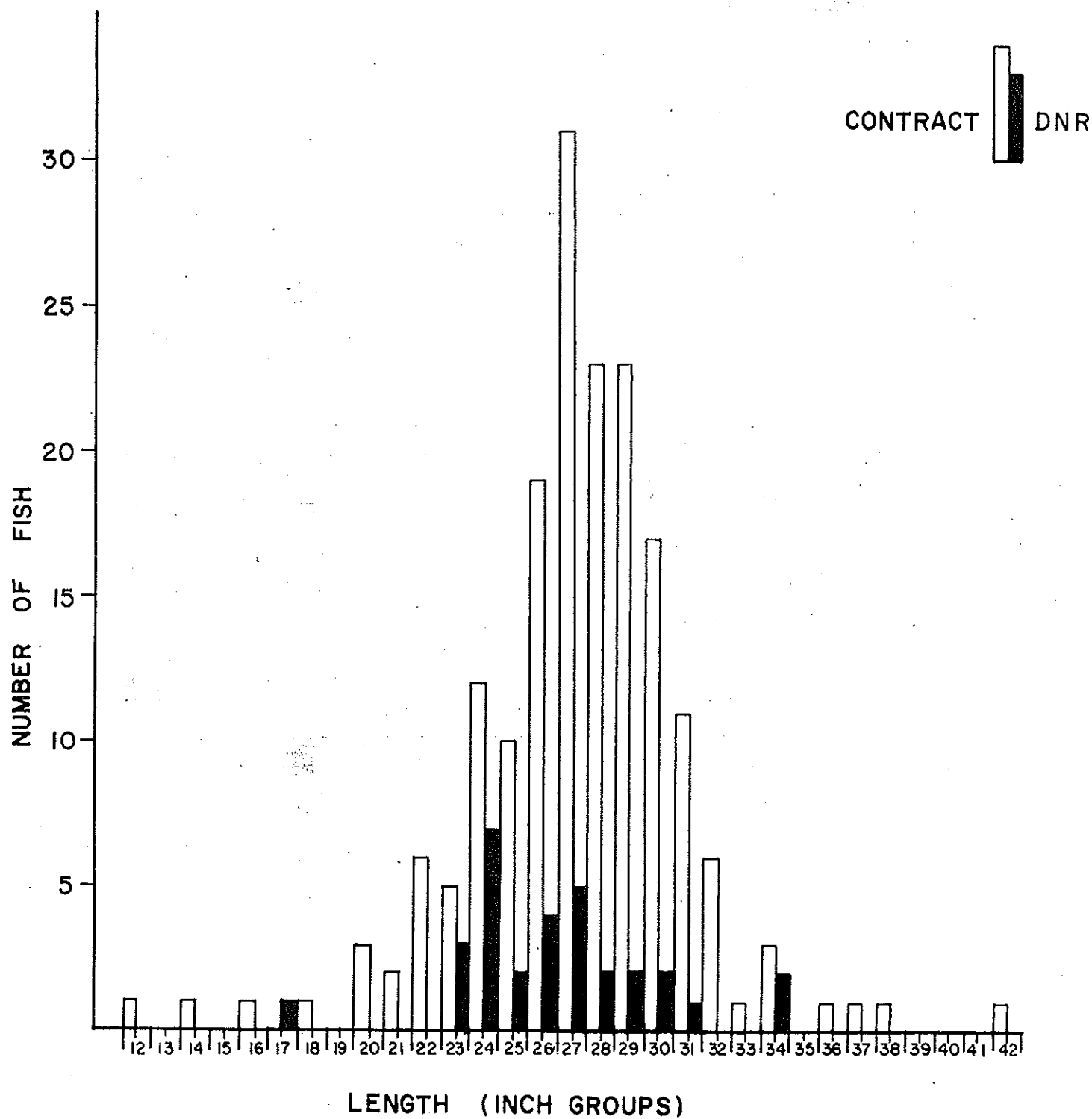


Figure 6. Length Frequency of Channel Catfish Taken in Contract and Department Nets.

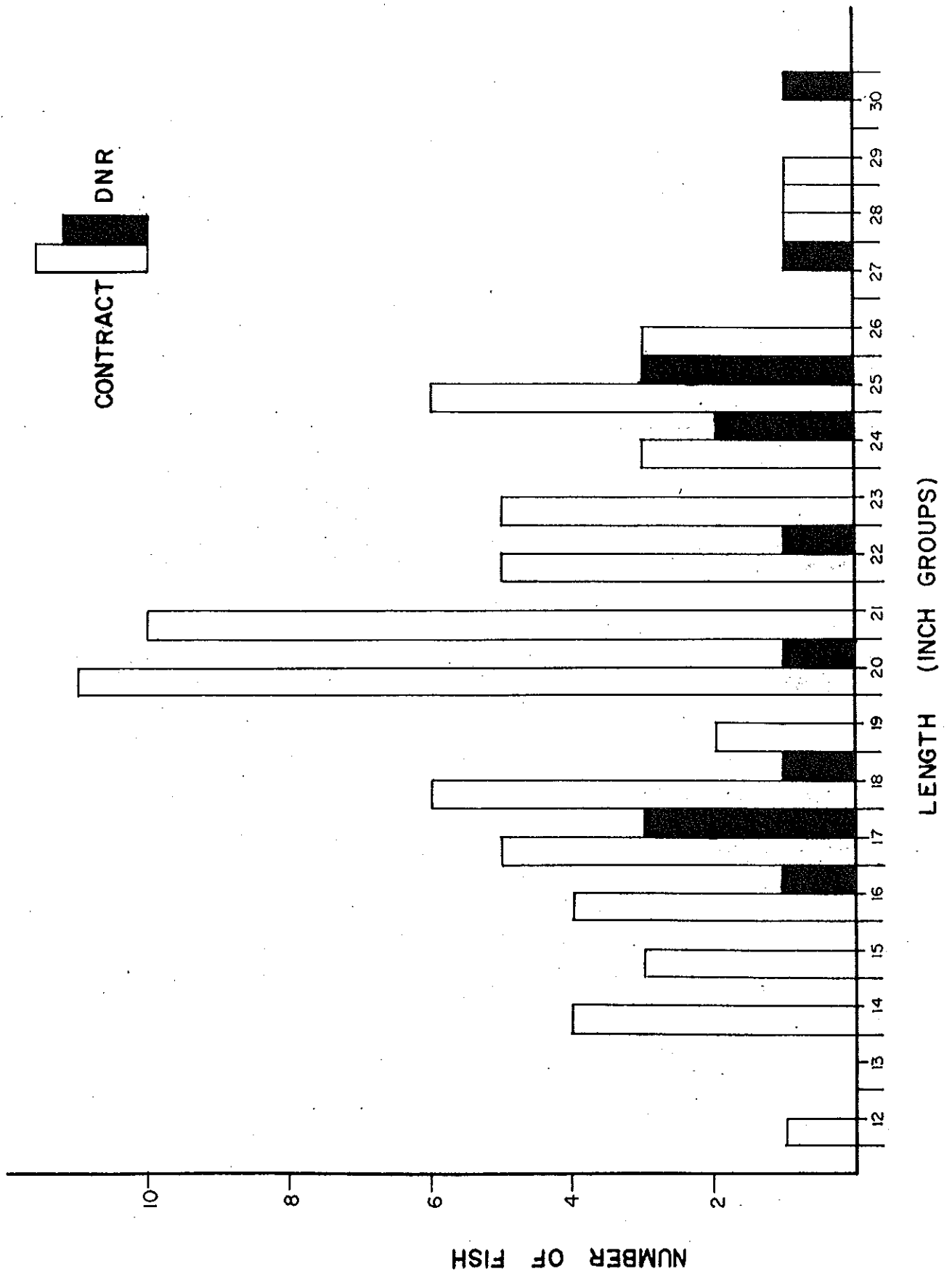


Figure 7. Length Frequency of Game Fish Taken in Contract and Department Nets.

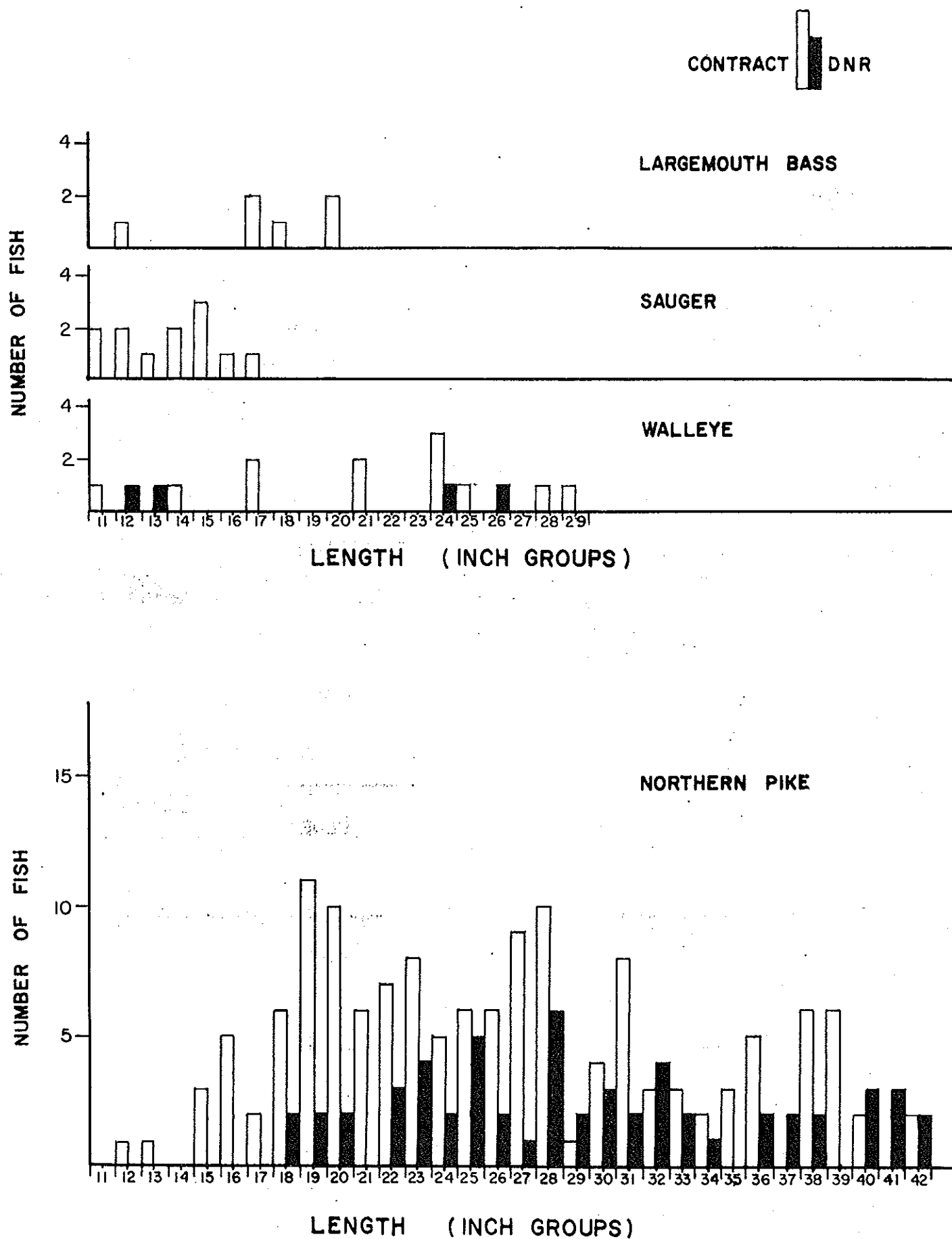


Figure 8. Length Frequency of Panfish Taken in Contract and Department Nets.

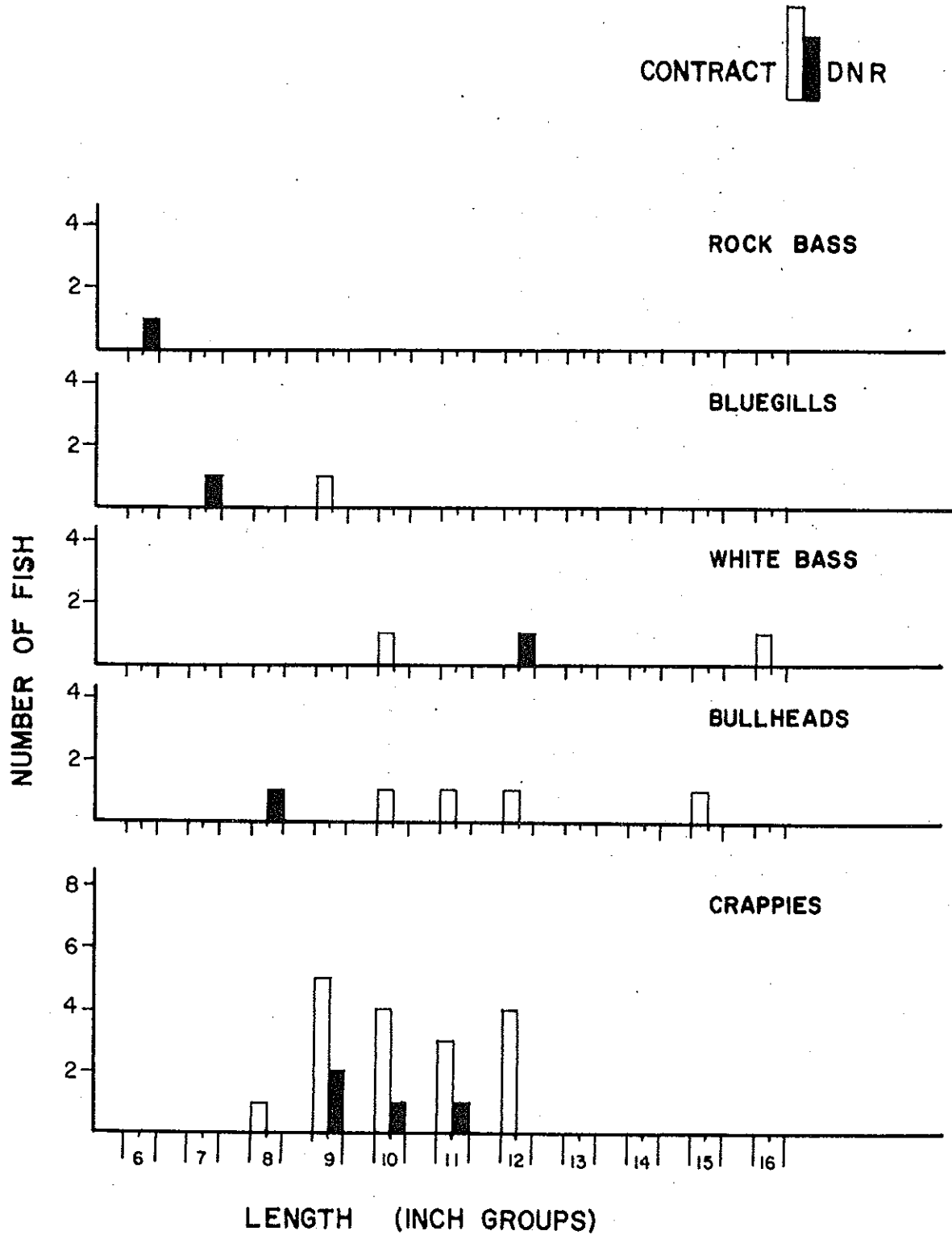
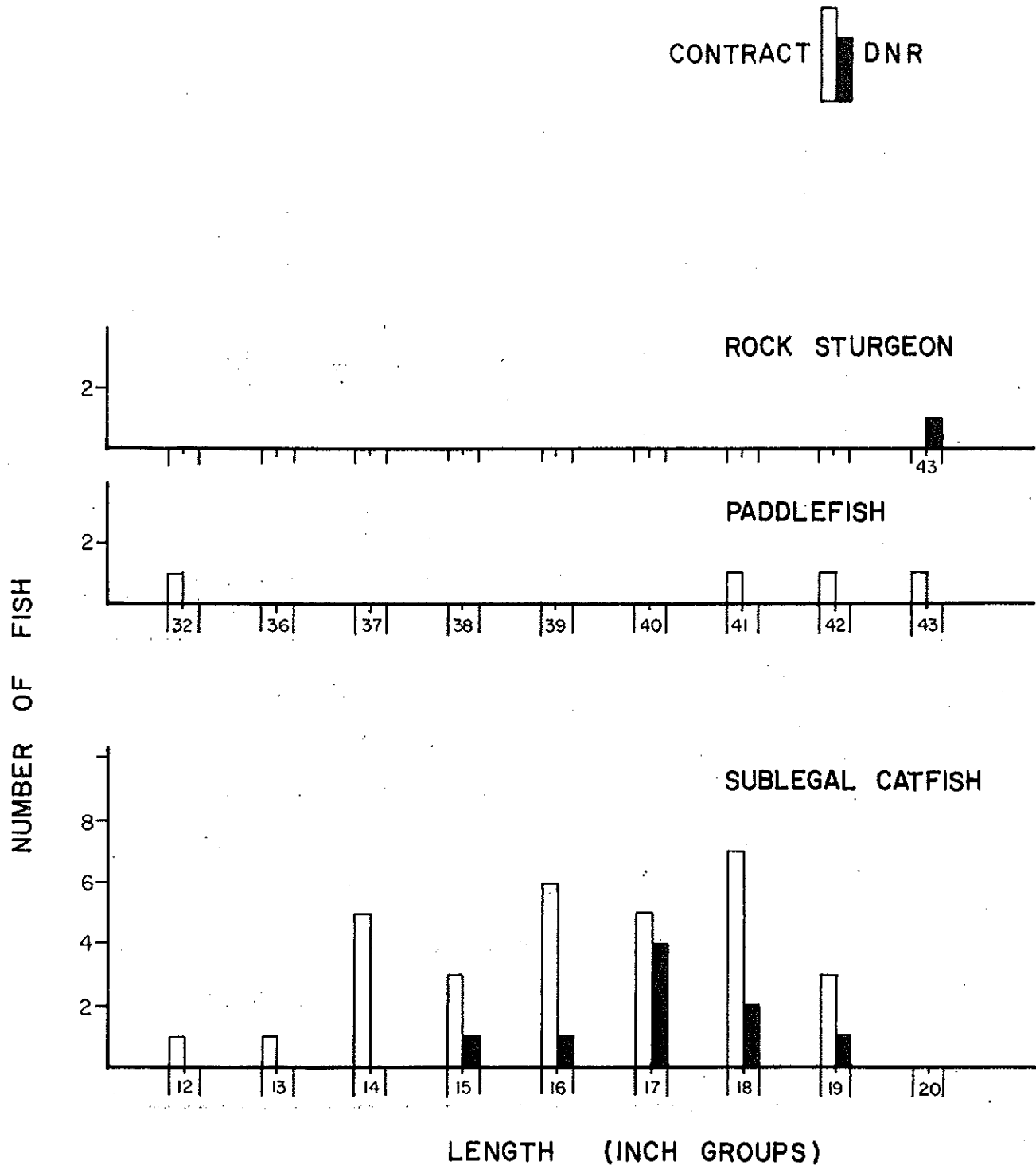


Figure 9. Other Non-Commercial Species Length Frequencies.



The size range of fish taken in Department nets was generally similar to that for contract nets. The influence of net mesh size on the size of fish taken was examined. Size selectivity was clearly evident for carp and buffalo (Figures 10 and 11). The numbers of fish taken decreased with increasing mesh size. The size peaks for carp were 23 to 24 inches for 7-inch nets, 26 to 27 inches for 8-inch nets, and 29 to 30 inches for 9-inch nets. The respective peaks for buffalo were at 19 inches, 24 inches, and 27 inches. Size selectivity was not evident for the other commercial and the non-commercial species.

Figure 10. Length Frequency of Carp in Department Nets by Mesh Size.

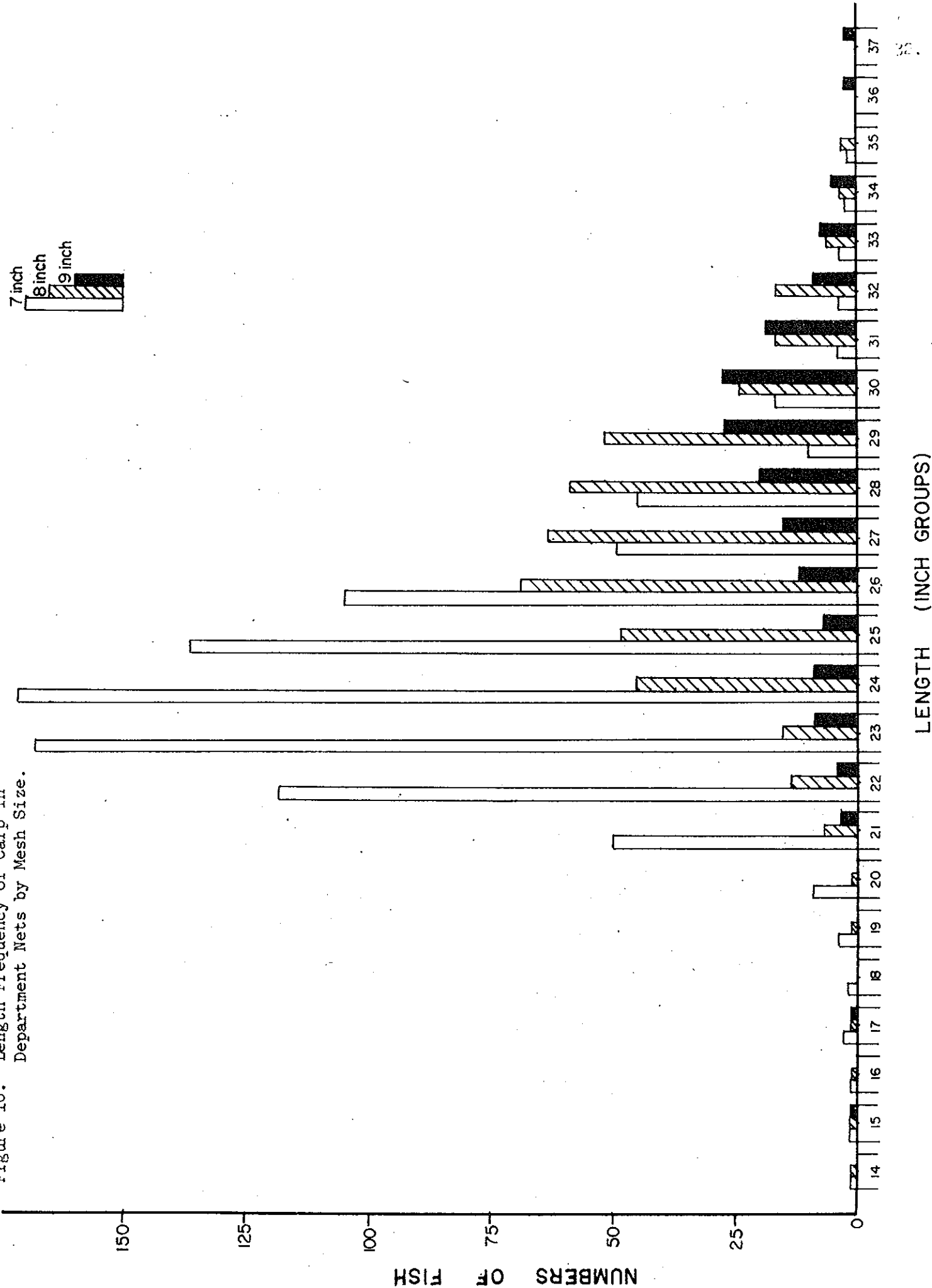
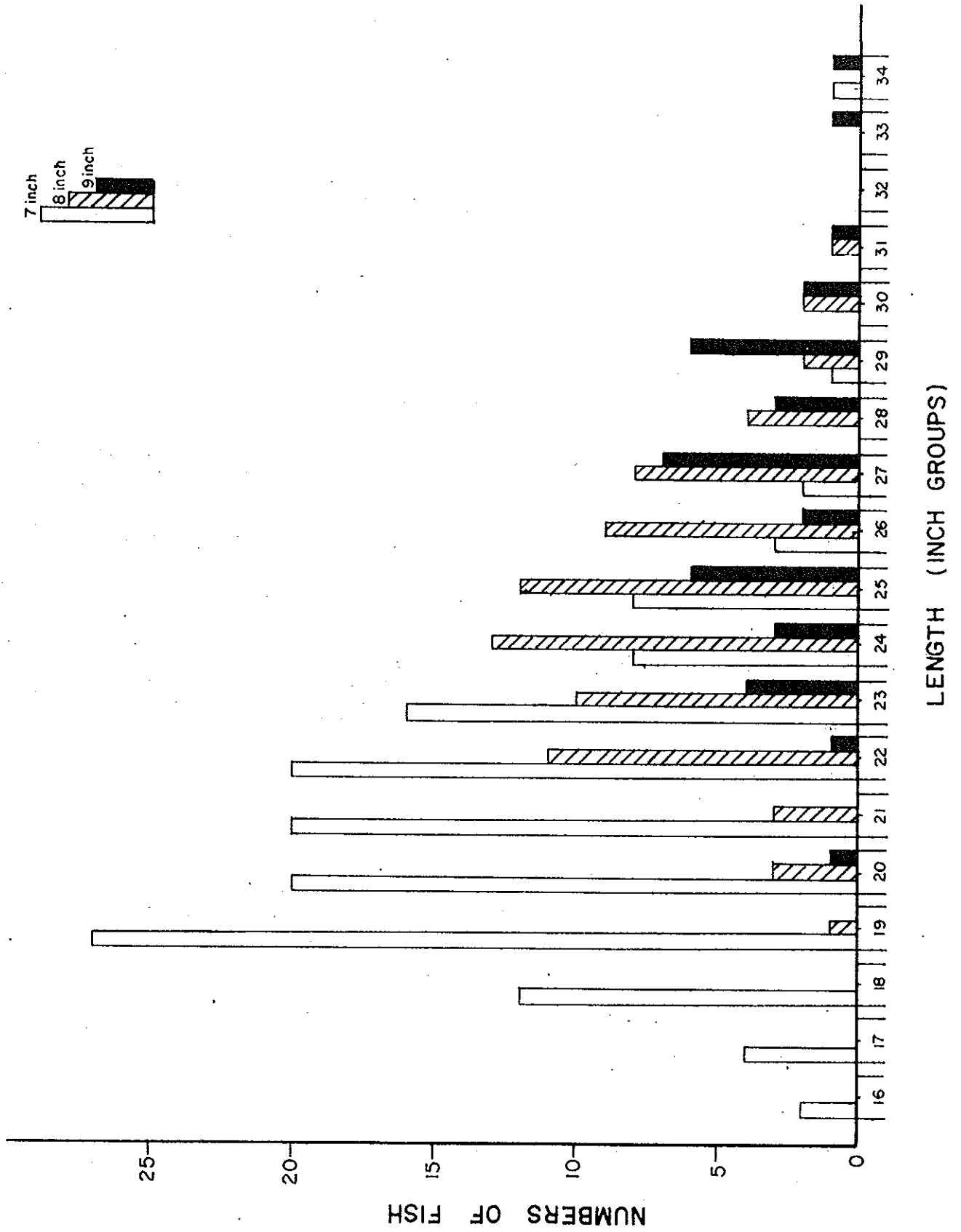


Figure 11. Length Frequency of Buffalo in Department Nets by Mesh Size.



EFFICIENCY

The catch rates per 1,000 feet of net fished for the major commercial species were 285.4 pounds of carp, 34.2 pounds of buffalo, 4.4 pounds of drum, and 4.0 pounds of catfish, for a total of 328.0 pounds of commercial fish (Table 5). The catfish catch per unit effort was made up of 3.5 pounds of flathead catfish and 0.5 pound channel catfish. Contract nets were more efficient than Department nets for commercial fish. Carp and buffalo catch rates were about twice as high for contract nets as for Department nets. Contract catch rates were one-third higher for drum and one-fourth higher for catfish. Annual fluctuations in contract and Department net catch rates were compared between the two study years. Carp and drum catch rates in contract nets varied less than 10 percent of the respective mean catch rates for the entire study, while buffalo and catfish showed more fluctuation, 10 to 20 percent of the mean. Buffalo and drum catch rates increased the second year, and carp and catfish declined. The catch rate for all commercial fish combined fluctuated only 3 percent of the mean, dropping slightly the second year. Annual Department net catch rates were more variable than those for contract nets. Carp were most stable, varying one-sixth of the mean. Fluctuations in the buffalo catch rate was one-third of the mean, and drum and catfish about two-thirds. Department net catch rates for all commercial species increased the second year, with the rate for all commercial fish combined fluctuating one-fifth of the mean.

Table 5. Catch (pound) Per Unit Effort (1,000 feet of net) of Major Commercial Species in Contract and Department Nets - May 1970 - April 1972

	Carp	Buffalo	Drum	Flathead Catfish	Channel Catfish	Total Catfish	Total All Species
<u>Contract Nets</u>							
1970-71	310.5	32.8	4.4	3.8	0.4	4.2	352.0
1971-72	294.0	39.6	4.7	3.3	0.5	3.8	342.1
1970-72 Combined	303.2	35.8	4.5	3.6	0.5	4.0	347.6

<u>Department Nets</u>							
1970-71	123.3	17.1	2.1	1.5	0.4	1.9	144.4
1971-72	144.9	23.7	4.1	3.4	0.7	4.1	176.9
1970-72 Combined	136.6	21.2	3.3	2.7	0.6	3.2	164.4

1970-71 Contract and Department Combined	296.3	31.6	4.2	3.6	0.4	4.0	336.1

1971-72 Contract and Department Combined	272.6	37.3	4.6	3.4	0.5	3.9	318.4

GRAND TOTAL 1970-72 Contract and Department Nets	285.4	34.2	4.4	3.5	0.5	4.0	328.0

Non-commercial catch rates were calculated on the basis of 100,000 feet of net, due to the smaller numbers of fish involved. At this rate, a total of 24 gamefish weighing 146 pounds were taken (Table 6). Included were 20.2 northern pike (133.7 pounds), 2.0 walleye (8.4 pounds), 1.2 sauger (1.1 pounds), and 0.6 largemouth bass (2.7 pounds). The panfish catch rate was 3.3 fish (2.5 pounds), including 2.1 crappies (1.4 pounds), 0.5 bullheads (0.5 pounds), 0.4 white bass (0.5 pounds), 0.2 bluegills (0.1 pounds), and 0.1 rock bass (0.05 pounds). Other non-commercial species were taken at a rate of 4.6 fish weighing 14.6 pounds: 4.1 sublegal catfish (7.4 pounds), 0.4 paddlefish (5.2 pounds), and 0.1 rock sturgeon (2.0 pounds) for 100,000 feet of net fished.

Department nets took northern pike at three times the rate of contract nets and walleyes at twice the rate of contract nets. No sauger or largemouth bass were taken in Department nets. Department nets also exceeded contract nets in panfish catch rates. The rate doubled for crappies and bullheads and tripled for white bass. Bluegills were caught in Department nets at nine times the rate in contract nets.

The waterfowl catch rate was 20 ducks per 100,000 feet of net for the combined spring and fall migration periods of both years of the study (Table 7). Department nets took ducks at a rate just over one-third higher than the contract net rate. The contract catch rate for ducks the second year was over twice that of the first year. Department nets produced 36 ducks per 100,000 feet of net the first year, with none caught the second year. The catch rate during the fall migration was over ten times higher than for the spring migration. Contract nets took ducks at a rate of 28 per 100,000 feet of net for both falls combined; 18 ducks the first fall and 50 ducks the second fall.

Table 6. Catch (numbers and pounds) Per Unit Effort (100,000 feet of net) for Non-Commercial Fish in Contract and Department Nets, May 1970 - April 1972

Species		Contract Nets			Department Nets			Grand Total
		1970-71	1971-72	Combined	1970-71	1971-72	Combined	
Northern Pike	Number	18.86	13.06	16.30	45.78	57.14	52.78	20.20
	Pounds	120.30	77.37	101.30	291.60	472.20	403.70	133.70
Walleye	Number	1.39	2.26	1.78	2.41	4.51	3.70	1.98
	Pounds	6.15	9.04	7.43	19.28	15.04	16.67	8.42
Sauger	Number	1.98	0.50	1.33	None	None	None	1.19
	Pounds	1.79	0.50	1.22				1.09
Largemouth Bass	Number	0.99	0.25	0.66	None	None	None	0.59
	Pounds	4.17	1.51	2.99				2.67
Total Game Fish	Number	23.22	16.08	20.07	48.19	61.65	56.48	23.96
	Pounds	132.40	88.42	113.00	310.80	487.20	420.40	145.90
<hr/>								
Crappie	Number	2.38	1.26	1.88	None	6.02	3.70	2.08
	Pounds	1.59	1.00	1.33		3.01	1.85	1.39
Bullhead	Number	0.40	0.50	0.44	None	1.50	0.93	0.50
	Pounds	0.40	0.50	0.44		1.50	0.93	0.50
White Bass	Number	0.20	0.50	0.33	2.41	None	0.93	0.40
	Pounds	0.20	0.75	0.44	2.41		0.93	0.50
Bluegill	Number	None	0.25	0.11	None	1.50	0.93	0.20
	Pounds		0.13	0.06		0.75	0.46	0.10
Rock Bass	Number	None	None	None	None	1.50	0.93	0.10
	Pounds					0.75	0.46	0.05
Total Panfish	Number	2.98	2.51	2.77	2.41	10.53	7.41	3.27
	Pounds	2.18	2.39	2.27	2.41	6.02	4.63	2.52
<hr/>								
Sublegal Catfish	Number	4.17	2.76	3.55	4.82	10.53	8.33	4.06
	Pounds	6.95	5.02	6.10	9.64	24.06	18.52	7.43
Paddlefish	Number	0.60	0.25	0.44	None	None	None	0.40
	Pounds	8.73	2.26	0.59				5.25
Rock Sturgeon	Number	None	None	None	None	1.50	0.93	0.10
	Pounds					30.08	18.52	1.98
Total Other Species	Number	4.76	3.01	3.99	4.82	12.03	9.26	4.56
	Pounds	15.68	7.28	11.97	9.64	54.14	37.04	14.65
<hr/>								
GRAND TOTAL All Species	Number	30.96	21.60	26.83	55.42	84.21	73.15	31.79
	Pounds	150.30	98.09	127.20	322.90	547.40	462.00	163.00

Table 7. Catch (numbers) Per Unit Effort (100,000 feet of net) for Waterfowl in Contract and Department Nets During October-November 1970, 1971 and April 1971, 1972

FALL							
Species	Contract Nets			Department Nets			Grand Total
	1970	1971	Combined	1970	1971	Combined	
Scaup	7.45	48.74	20.12	61.64	-	37.74	22.05
Canvasback	8.19	-	5.68	-	-	-	5.05
Scoter	0.74	-	0.52	-	-	-	0.46
Bufflehead	0.74	-	0.52	-	-	-	0.46
Merganser	-	1.68	0.52	-	-	-	0.46
Coot	0.74	-	0.52	-	-	-	0.46
-----	-----	-----	-----	-----	-----	-----	-----
TOTAL	17.87	50.42	27.86	61.64	-	37.74	28.95

SPRING							
Species	Contract Nets			Department Nets			Grand Total
	1971	1972	Combined	1971	1972	Combined	
Scaup	-	4.40	2.03	7.60	-	6.58	2.63
-----	-----	-----	-----	-----	-----	-----	-----
Spring and Fall Combined							
Species	1970-71	1971-72	Combined	1970-71	1971-72	Combined	Grand Total
Scaup	5.33	29.53	14.02	36.04	-	25.61	15.38
Canvasback	5.87	-	3.76	-	-	-	3.32
Scoter	0.53	-	0.34	-	-	-	0.30
Bufflehead	0.53	-	0.34	-	-	-	0.30
Merganser	-	0.95	0.34	-	-	-	0.30
Coot	0.53	-	0.34	-	-	-	0.30
-----	-----	-----	-----	-----	-----	-----	-----
TOTAL	12.80	30.48	19.15	36.04	-	25.61	19.91

The fall Department net catch rate was $3\frac{1}{2}$ times the contract net rate in 1970, and one-third higher for both years combined.

The catch rates for the two major duck species were 15.4 scaup and 3.3 canvasbacks per 100,000 feet of net for the entire study. The contract net rates were slightly lower for scaup and slightly higher for canvasback. For contract nets during the fall period only, the catch rates for both species were higher than the overall rates. Canvasback were only taken in contract nets the first fall, and all ducks taken during the second year of the study were scaup.

The spring catch rate per 100,000 feet was 4.4 ducks for contract nets the second year and 7.6 ducks for Department nets the first year. With none taken in other respective springs, the average rates were 2.0 ducks for contract nets and 6.6 ducks for Department nets. Considering the catch rates for the two major species of ducks taken, canvasbacks exceeded scaup slightly for contract nets the first fall. This was the only netting that produced canvasbacks during the study, so that for both years combined, scaup catch rates were $3\frac{1}{2}$ to $4\frac{1}{2}$ times canvasback rates. Fall scaup catch rates per 100,000 feet were as high as 49 ducks for contract nets and 62 ducks for Department nets. Spring rates were much lower, with a maximum of 4 ducks for contract nets and 8 ducks for Department nets. The canvasback catch rate ranged from 8 ducks for contract nets the first fall to 3 ducks for all spring and fall contract and Department netting during the study.

Efficiency by Month

Catch rates for commercial fish were examined by month to determine how efficiency varied seasonally. The carp catch rate in contract nets ranged from 16 to 63 pounds per 100 feet of net (Figure 12). Highest rates occurred in early spring and late fall, and lowest rates from mid-summer through late summer or early fall. Rates for Department nets were similar for all months (10 to 20 pounds per 100 feet) with three exceptions. November catch rates were very low, mainly because areas where large carp concentrations were already being fished under contract were not fished with Department nets. August also had a low catch rate, the only similarity in Department and contract results. Highest Department net catch rates occurred under the ice in January, and were comparable to high contract net rates. Most of the January catch came from a heavy carp concentration in one location.

Catch rates for buffalo ranged from 10.5 to 0.1 pounds per 100 feet of contract net (Figure 13). Highest rates were found from early spring through early summer, and lowest rates from late summer through late fall. Department net catch rates ranged from 8 pounds to none, and fluctuated erratically instead of following a consistent seasonal pattern. Peak catches occurred in August and November, and low rates were found in middle through late summer, fall, and late winter.

Drum catch rates in contract nets ranged from 10 pounds to none per 1,000 feet of net (Figure 14). Summer months were the best producers, and early spring and late fall the lowest. Department catch rates covered a similar range, 13 pounds to none per 1,000 feet of net. Seasonal trends were also similar to contract nets, highest in mid-summer and lowest in early spring and late fall.

Figure 12. Carp Catch Per Unit of Effort.

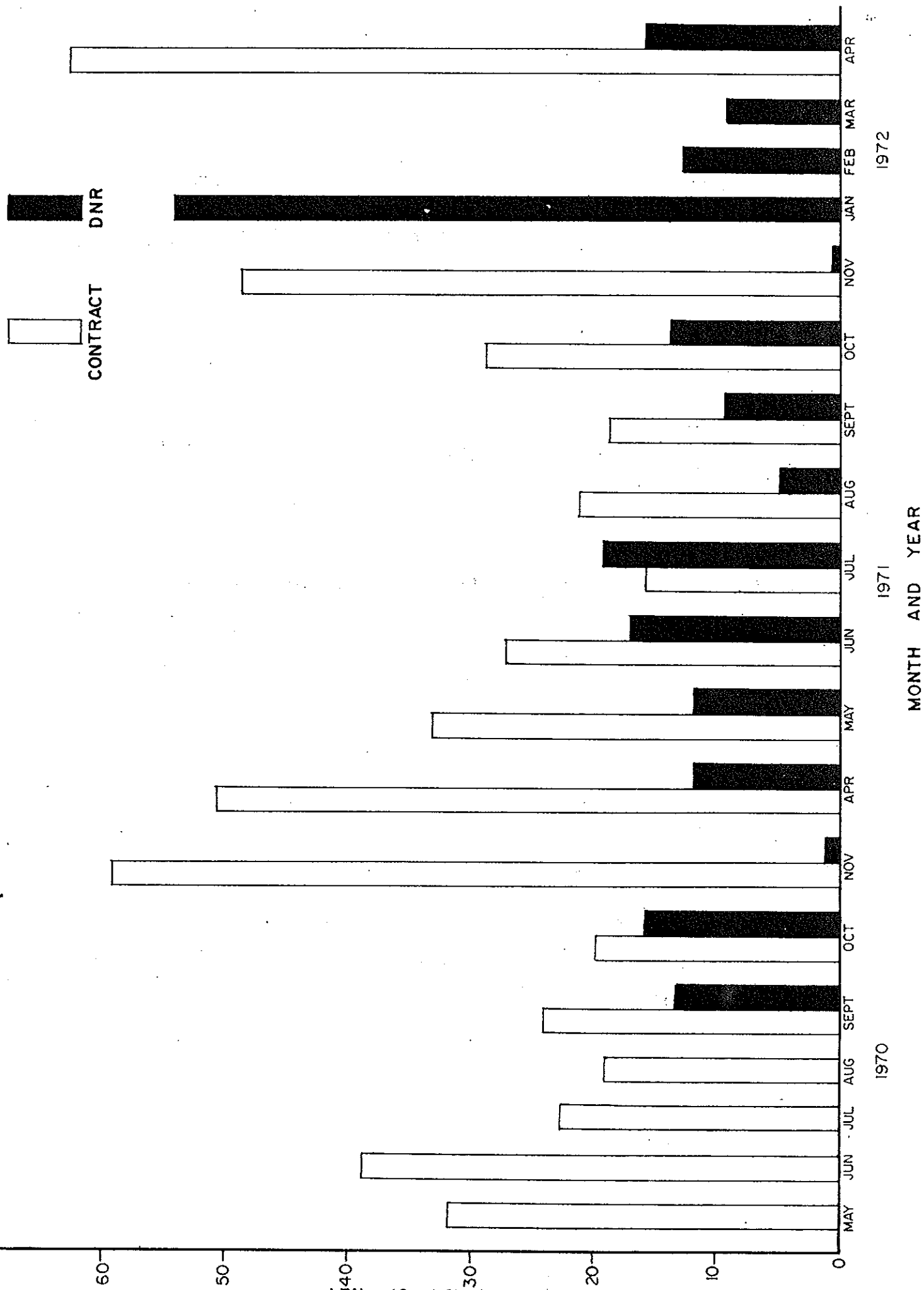


Figure 13. Buffalo Catch Per Unit of Effort.

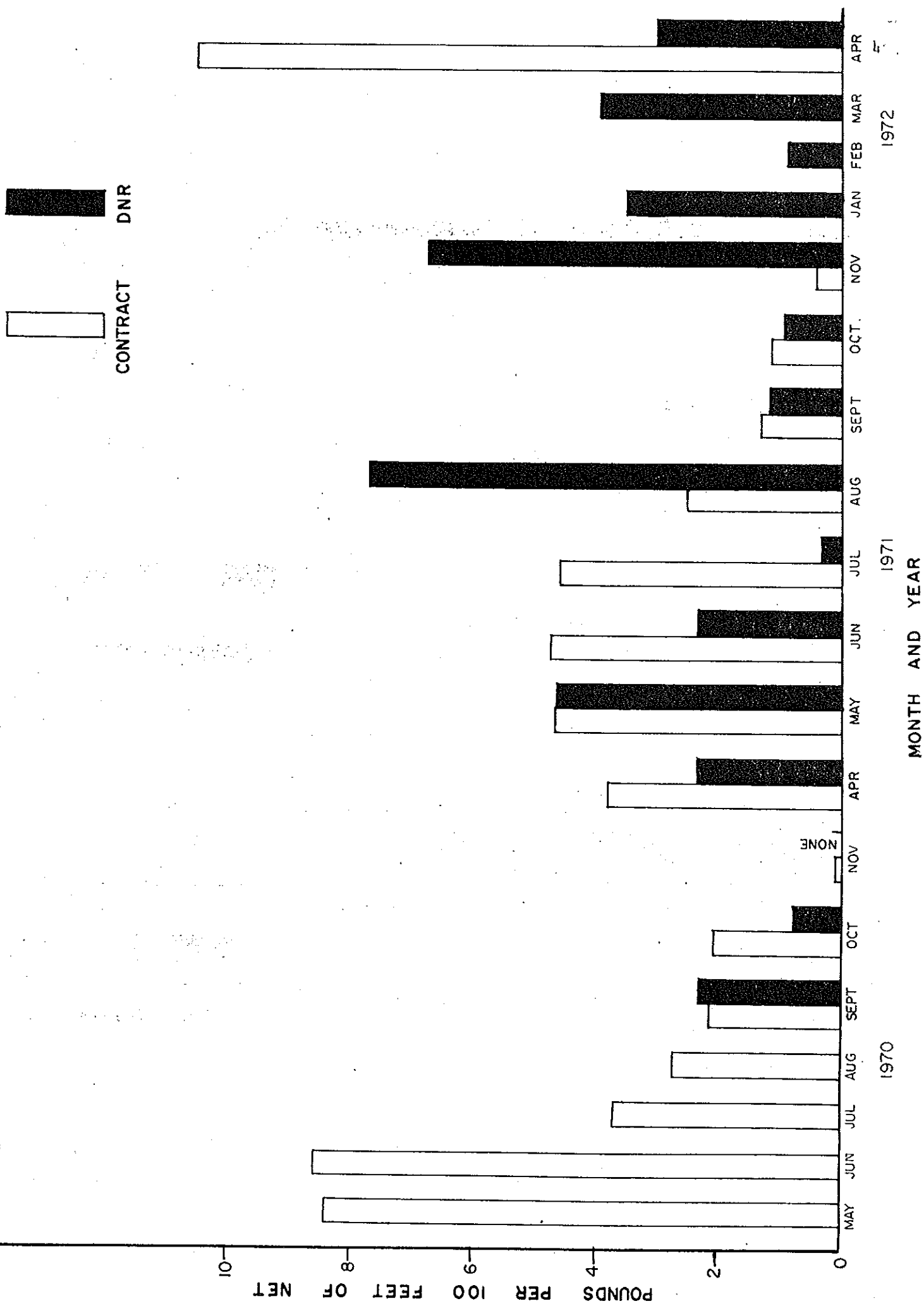


Figure 14. Freshwater Drum Catch Per Unit of Effort.

CONTRACT
DNR

12

10

POUNDS PER 1000 FEET OF NET

4

2

APR

MAR

FEB

JAN

NOV

OCT

SEPT

AUG

JULY

JUNE

MAY

APR

NOV

OCT

SEPT

AUG

JUL

JUN

MAY

1972

1971

1970

MONTH AND YEAR

NONE

NONE

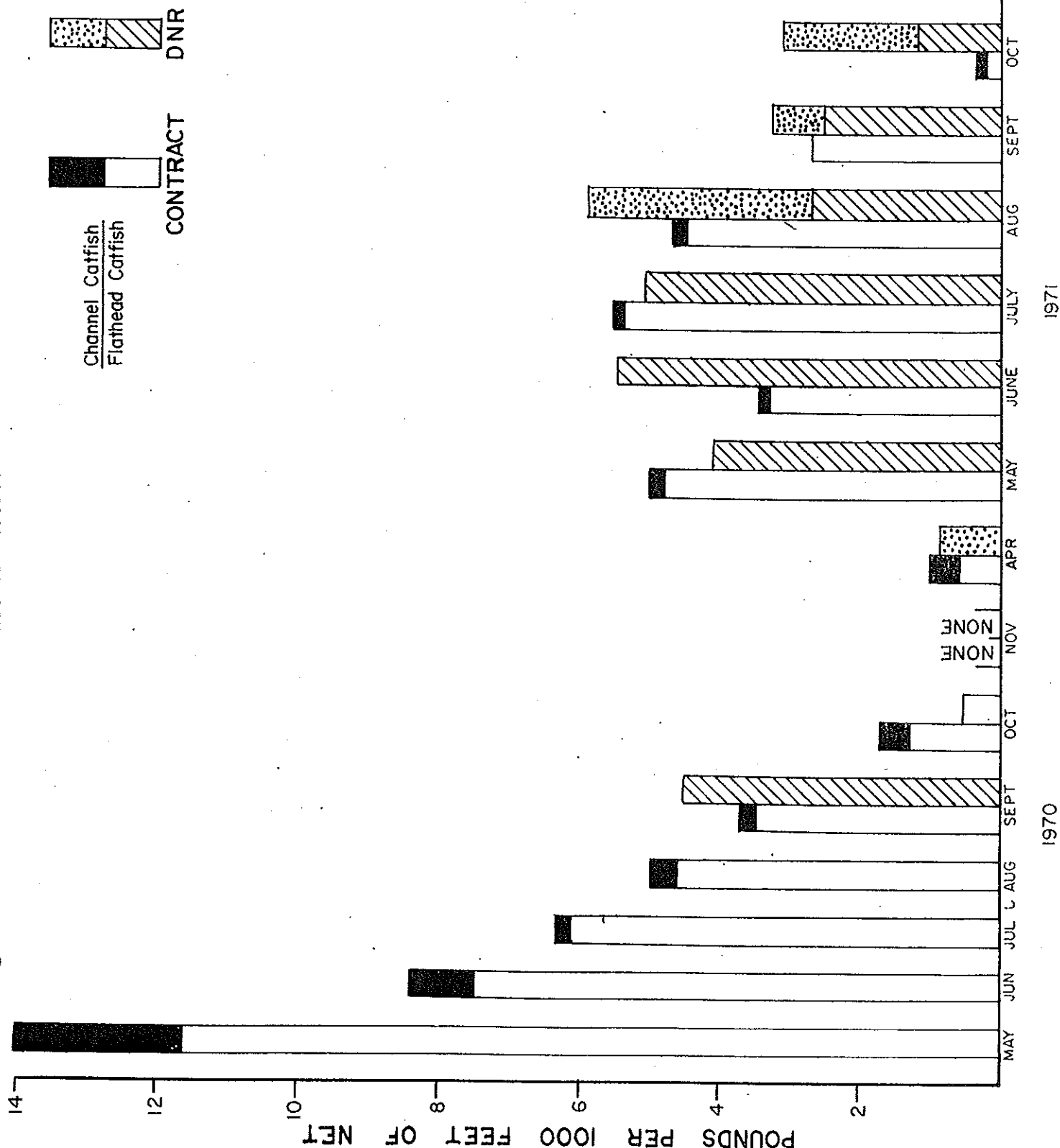
Seasonal catch rates for flathead catfish in contract nets differed considerably between the two study years (Figure 15). Rates ranged from 12 pounds to none per 1,000 feet of net the first year, highest in late spring and early summer and lowest in early spring and late fall. The second year peak catch rates were only half as high^{and}, similar from late spring through late summer. Low rates again occurred in fall and early spring. Flathead catch rates for Department nets ranged from 8 pounds to none. High rates occurred in winter and from late spring through late summer. Early spring and fall had the lowest rates.

Contract catch rates for channel catfish ranged from 3.5 pounds to none, with highest rates occurring in spring and lower rates in all other months. Department net rates covered a similar range, with peaks in early spring and mid-summer, and all other months low.

Seasonal efficiency for non-commercial fish was also determined. The northern pike catch rate in contract nets ranged from 5.8 to 0.1 fish per 10,000 feet of net. Highest rates occurred in spring and fall, and lowest in summer. Department net rates were highest in early spring and winter, and lowest in mid-summer and late fall, ranging from 45 fish to none per 10,000 feet of net.

Walleye catch rates in contract nets ranged from 0.7 fish to none per 10,000 feet of net. Early spring fishing produced the highest rate, and late fall the lowest. Monthly rates varied considerably between the two years. Department net catch rates for walleyes ranged from 5.5 to none per 10,000 feet of net. The highest rate occurred in late winter, with late summer producing the only other walleyes, 1.0 to 1.5 per 10,000 feet of net.

Figure 15. Catfish Catch Per Unit of Effort.



Largemouth bass catch rates ranged from 0.4 to none per 10,000 feet of contract nets. Rates were highest from early spring through early summer, and absent at all other times except for a low rate in late fall. Sauger catch rates ranged from 0.5 fish to none per 10,000 feet in contract rates, with peak catches in early and mid-summer. Late spring and late summer through early fall produced sauger at lower rates, with none taken at other times. Largemouth bass and sauger did not appear in Department nets.

Seasonal catch rates for panfish ranged from 7.5 to none per 100,000 feet of contract net fished. Highest rates appeared in late spring and late fall, and lowest in summer and early fall. Crappies and bullheads were the most significant species. Rates for Department nets ranged from 83 fish to none per 100,000 feet of net with highest rates in late fall and mid-summer. Crappie was the most significant species. Early spring and early and late summer produced panfish at lower catch rates, with none appearing at any other time.

Sublegal catfish catch rates in contract nets ranged from 17.5 fish to none per 100,000 feet of net. Highest rates appeared in late spring, with lower rates in summer and none in early spring or fall. Department net rates ranged from 54 catfish to none, with a peak in late winter. Lower rates appeared from late spring through early fall, with none in early spring or late fall. Catch rates for paddlefish were highest in late spring, and lower in mid- and late summer. They appeared in contract nets only, at rates of 3.5 to 0.9 fish per 100,000 feet of net. Rock sturgeon appeared in Department nets in early spring only at a rate of 7.5 fish per 100,000 feet of net. The seasonal nature of waterfowl catches was discussed earlier in the text.

Efficiency by Area

Catch rates for commercial fish were compared between six study areas to determine the influence of location on efficiency. Carp catch rates by area ranged from 12 to 48 pounds per 100 feet of gill net for contract nets and 4.5 to 17.5 pounds for Department nets. The west central area had consistently high rates both years for contract and Department nets. Rates were more variable in the upper and middle pool areas, but were more often high than low. Contract and Department net rates varied from high to low between the two years in the north area. East central and south areas had consistently low rates for contract and Department nets.

Buffalo catch rates varied from 7.3 pounds (contract nets) and 8.2 pounds (Department nets) per 100 feet of net in the highest areas to 0.2 pounds (contract nets) and 0.5 pound (Department nets) in the lowest areas .

The south area had high catch rates for contract and Department nets both years. The upper pool produced comparably high contract net rates, but low Department net rates. Intermediate rates for contract and Department nets occurred in the north area. The east central area contract rates were similar to those of the north area, but Department net rates were considerably lower. Contract and Department net rates were lowest in the west central and middle pool areas.

Area catch rates for drum ranged from highs of 6.1 pounds (Department nets) and 8.2 pounds (contract nets) to lows of 1.0 pounds (Department nets) and 1.4 pounds (contract nets). Considerable variability in annual contract and Department net catch rates occurred in most areas. Based on average catch rates, the south area ranked first, followed by the east central and then the north area. The west central, upper pool, and middle pool had the lowest catch rates, listed in decreasing order.

Catfish catch rates also fluctuated considerably between years, and contract and Department nets had high and low rates in different areas.

Flathead catfish catch rates varied from highs of 10.5 pounds per 1,000 feet (contract nets) and 9.4 pounds (Department nets) to lows of 0.3 pounds (contract nets) and 0.5 pounds (Department nets). The middle pool produced no flathead catfish in contract or Department nets. Contract net rates averaged highest in the south area, followed by the east central, with the north section ranking third. The west central area followed by the upper pool had the lowest rates. Department net rates were highest in the upper pool and north areas, with the east central and south intermediate, and the west central lowest.

Channel catfish catch rates ranged from 2.6 pounds (contract nets) and 1.4 pounds (Department nets) per 1,000 feet to 0.1 pounds (contract nets) and 0.4 pounds (Department nets). The upper pool had the highest contract catch rate for channel catfish, with the south and east central sections intermediate, and the north, west central, and middle pool areas low. Department net rates were highest in the east central and west central areas, intermediate in the upper pool and low in the middle pool and north areas. The south area produced no channel catfish in Department nets.

Considering catch rates by area for non-commercial species, northern pike ranged from 16.8 fish per 10,000 feet (Department nets) and 5.5 fish (contract nets) to 0.3 fish (contract nets) and 0.8 fish (Department nets).

The highest area catch rates for northern pike occurred in the upper pool, for contract nets during the first year and for Department nets during the second year. The remaining upper pool rates were intermediate and similar to those for all other areas except the east central and south, where catch rates were lowest.

Area catch rates for walleyes ranged from 6.1 fish per 100,000 feet (contract nets) and 9.9 fish (Department nets) to 0.7 fish (contract nets) and 6.1 fish (Department nets). No walleyes appeared in contract nets in the middle pool or in Department nets in the west central or south areas. Contract net rates were highest in the upper pool, and intermediate in all other areas where walleye were caught, except for low rates the first year in the west central and east central areas. The highest Department net rate occurred in the north area, followed by the intermediate east central and upper pool rates, with the middle pool lowest of the areas where walleye were caught.

Sauger catch rates ranged from 7.9 to 1.2 fish per 100,000 feet of net in areas where this species was taken. The middle pool and south areas had the highest annual rates observed. Similar low annual rates occurred in the upper and middle pool and north and east central areas. No sauger appeared in the west central section either year or in the south section the second year.

Similar largemouth bass catch rates occurred in the west central and south areas the first year and the upper pool the second (2.4 to 1.7 fish per 100,000 feet of net), and did not appear elsewhere.

Panfish catch rates in Department nets ranged from 4.2 to 0.2 fish per 10,000 feet of net. The highest catch rates occurred in the upper pool and north area the second year. The middle pool and west central area the second year and the upper pool the first year had intermediate catch rates. The north section had a low rate the first year, and no panfish appeared in Department nets in the east central and south sections either year. Panfish catch rates in contract nets ranged from 0.6 to 0.1 fish per 10,000 feet of net.

Highest catch rates occurred in the upper pool and east central areas the first year and the west central area of the lower pool the second year. The middle pool and west central area the first year, the east central area the second year, and the south area both years, had low rates. Contract nets in the north area took no panfish either year.

Sublegal catfish catch rates ranged from 4.0 fish per 10,000 feet (Department nets) and 1.3 fish (contract nets) to 0.8 fish (Department nets) and 0.1 fish (contract nets). Highest rates for contract and Department nets occurred in the south area. The north and east central areas had intermediate contract catch rates in at least one year, and the north and west central areas intermediate Department catch rates. Low catch rates for contract nets occurred in the north and west central areas, and for Department in the east central area and upper pool. The upper pool produced no sublegal catfish in contract nets, and the middle pool none in Department nets. Paddlefish appeared in only the east central and south areas, with the highest catch rate in the south. The catch rate range was 2.5 to 0.5 fish per 100,000 feet of net. The only sturgeon taken came from the upper pool, a catch rate of 0.8 fish per 10,000 feet of net.

Waterfowl catch rates by area were calculated for the spring and fall migration months only. Scaup and canvasback catch rates were highest in the north section, 16.5 and 1.8 ducks per 10,000 feet for the respective species during the fall migration. Scaup were taken at lower rates in all other study areas except the middle pool. Canvasback appeared at a lower rate only in the west central area. Department nets took ducks in only two areas. The east central area produced 24.2 scaup in the fall and the upper pool 1.2 scaup in the spring per 10,000 feet of net.

Effect of Mesh Size on Efficiency of Gill Nets for Fish and Ducks

A comparison of the efficiency of three mesh sizes (7, 8, and 9-inch mesh) was possible for Department net fishing, as the length and weight of all fish taken were recorded by mesh size. The smallest mesh size was most efficient for commercial species (Table 8a). Efficiency dropped 28 percent for carp and 19 percent for buffalo for 8-inch nets and 62 percent for carp and 34 percent for buffalo in 9-inch nets. Efficiency rates for drum were identical for 7- and 8-inch nets, and dropped 51 percent for 9-inch mesh. Catfish catch efficiency was considerably higher for 7-inch nets. A drop of 72 percent in 8-inch and 73 percent in 9-inch nets occurred for flathead catfish and 73 percent for 8-inch and 65 percent for 9-inch for channel catfish.

The 7-inch nets were also most efficient for non-commercial fish (Table 8b). Northern pike catch rates dropped 28 percent by number and 34 percent by weight in 8-inch mesh, and 36 percent by number and 60 percent by weight in 9-inch mesh. By number, walleye catch rates dropped by one-half from 7 inches to both 8 and 9-inch nets. Catch rates by weight for 7 and 8-inch nets were the same, and dropped 94 percent for 9-inch nets. Crappie catch rates dropped by one-half by number and two-thirds by weight in both 8 and 9-inch nets. Catch rates for all panfish dropped slightly for 8-inch nets (24 percent by number and 9 percent by weight), and considerably for 9-inch nets (74 percent by number and 77 percent by weight). Sublegal catfish rates declined sharply (80 to 87 percent) for both 8 and 9-inch nets. Duck catch rates were equal for 8 and 9-inch nets, with none appearing in 7-inch nets.

Table 8a. Catch (pounds) Per Unit Effort (1,000 feet of net) for Major Commercial Fish in Department Nets by Mesh Size.

Species	MESH SIZE		
	7-inch	8-inch	9-inch
Carp	193.4	139.8	73.2
Buffalo	25.6	20.6	16.9
Drum	4.0	4.0	2.0
Flathead Catfish	5.2	1.4	1.4
Channel Catfish	0.9	0.2	0.3
All Commercial Species	209.1	166.0	93.8

Table 8b. Catch (numbers^{and pounds}) per Unit Effort (100,000 feet of net) for Non-Commercial Fish in Department Nets by Mesh Size

Species	MESH SIZE					
	7-inch		8-inch		9-inch	
	Number	Pounds	Number	Pounds	Number	Pounds
Northern Pike	65.4	516.0	47.2	338.0	42.0	206.0
Walleye	5.4	23.2	2.8	23.6	2.8	1.4
Crappie	5.4	4.1	2.8	1.4	2.8	1.4
Sublegal Catfish	19.1	42.2	2.8	8.3	2.8	5.6
Scaup	None	-	13.9	-	14.0	-
All Game Fish	70.8	539.2	50.0	361.6	44.8	207.4
All Panfish	10.9	6.1	8.3	5.6	2.8	1.4

MORTALITY OF NON-COMMERCIAL FISH AND WATERFOWL

The mortality of non-commercial fish and waterfowl in gill nets (those unable to successfully recover from injuries encountered in capture) is a primary significance in evaluating the negative effects of the fishery. Actual mortality consists of obvious mortality (fish and ducks dead in the nets) plus delayed mortality occurring after release. Delayed mortality may range from potential mortality (all released may die) to none (all released survive). Intermediate is probable mortality, fish released with visible injuries.

Absolute mortality for all non-commercial fish taken during the study in both contract and Department nets amounted to one-fourth of the catch by number and one-fifth by weight (Table 9). Probable mortality involved just over one-third of the catch by number and by weight (Table 10). Department net rates were higher than contract net rates for both absolute mortality (one-third and one-fifth of the catch, respectively) and probable mortality (three-fifths and one-fourth of the catch, respectively). Annual absolute mortality rates ranged from 15 to 23 percent for contract nets and 24 to 49 percent for Department nets. For probable mortality, the rates increased to 22 to 29 percent for contract nets and 49 to 80 percent for Department nets.

In general, gamefish mortality rates slightly exceeded those for all non-commercial fish combined (2 to 8 percent higher). The only exception was Department net absolute mortality the second year, when low gamefish mortality and high panfish mortality coincided. Panfish mortality rates were generally lower than those for gamefish in contract nets, with 18 to 27 percent mortality the first year and none the second, for an average range of 10 to 16 percent. In Department nets panfish mortality was considerably higher than gamefish mortality, generally between 60 and 100 percent. Sublegal catfish had the lowest mortality rates, ranging from 15 percent to none.

Table 9. Non-Commercial Fish Dead (absolute mortality) in Contract and Department Nets, May 1970 - April 1972.

	Contract Nets						Department Nets						Grand Total	
Species	1970-71		1971-72		Combined		1970-71		1971-72		Combined			
	No.	Lb.	No.	Lb.	No.	Lb.	No.	Lb.	No.	Lb.	No.	Lb.	No.	Lb.
Northern Pike	18	85.5	18	80.0	36	165.5	7	58.0	11	74.0	18	132.0	54	297.5
Walleye	4	16.0	2	8.0	6	24.0	1	7.5	2	9.5	3	17.0	9	41.0
Sauger	6	5.0	0	0.0	6	5.0	-	-	-	-	-	-	6	5.0
Largemouth Bass	1	3.0	0	0.0	1	3.0	-	-	-	-	-	-	1	3.0
Total Large Game Fish	29	109.5	20	88.0	49	197.5	8	65.5	13	83.5	21	149.0	70	346.5
Crappie	3	2.0	0	0.0	3	2.0	-	-	3	1.5	3	1.5	6	3.5
Bullhead	0	0.0	0	0.0	0	0.0	-	-	1	0.5	1	0.5	1	0.5
White Bass	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Bluegill	0	0.0	0	0.0	0	0.0	-	-	1	0.5	1	0.5	1	0.5
Rock Bass	-	-	-	-	-	-	-	-	1	0.5	1	0.5	1	0.5
Total Panfish	3	2.0	0	0.0	3	2.0	0	0.0	6	3.0	6	3.0	9	5.0
Sublegal Catfish	1	1.0	0	0.0	1	1.0	0	0.0	1	2.0	1	2.0	2	3.0
Paddlefish	0	0.0	0	0.0	0	0.0	-	-	-	-	-	-	0	0.0
Rock Sturgeon	-	-	-	-	-	-	0	0.0	-	-	0	0.0	0	0.0
Total Other Species	1	1.0	0	0.0	1	1.0	0	0.0	1	2.0	1	2.0	2	3.0
Grand Total All Species	33	112.5	20	88.0	53	200.5	8	65.5	20	88.5	28	154.0	81	354.5

Table 10. Non-Commercial Fish Dead or Visibly Injured (probable mortality) in Contract and Department Nets, May 1970 - April 1972.

	Contract Nets						Department Nets						Grand Total	
Species	1970-71		1971-72		Combined		1970-71		1971-72		Combined			
	No.	Lb.	No.	Lb.	No.	Lb.	No.	Lb.	No.	Lb.	No.	Lb.	No.	Lb.
Northern Pike	27	133.5	21	102.5	48	236.0	15	98.0	20	163.0	35	261.0	83	497.0
Walleye	4	16.0	2	8.0	6	24.0	1	7.5	2	9.5	3	17.0	9	41.0
Sauger	6	5.0	0	0.0	6	5.0	-	-	-	-	-	-	6	5.0
Largemouth Bass	2	9.5	0	0.0	2	9.5	-	-	-	-	-	-	2	9.5
Total Large Game Fish	39	164.0	23	110.5	62	274.5	16	105.5	22	172.5	38	278.0	100	552.5
Crappie	4	2.5	0	0.0	4	2.5	-	-	3	1.5	3	1.5	7	4.0
Bullhead	0	0.0	0	0.0	0	0.0	-	-	1	0.5	1	0.5	1	0.5
White Bass	0	0.0	0	0.0	0	0.0	1	1.0	0	0.0	1	1.0	1	1.0
Bluegill	0	0.0	0	0.0	0	0.0	-	-	1	0.5	1	0.5	1	0.5
Rock Bass	-	-	-	-	-	-	-	-	1	0.5	1	0.5	1	0.5
Total Panfish	4	2.5	0	0.0	4	2.5	1	1.0	6	3.0	7	4.0	11	6.5
Sublegal catfish	1	1.0	1	3.0	2	4.0	0	0.0	1	2.0	1	2.0	3	6.0
Paddlefish	0	0.0	0	0.0	0	0.0	-	-	-	-	-	-	0	0.0
Rock Sturgeon	-	-	-	-	-	-	0	0.0	-	-	0	0.0	0	0.0
Total Other Species	1	1.0	1	3.0	2	4.0	0	0.0	1	2.0	1	2.0	3	6.0
Grand Total All Species	44	167.5	24	113.5	68	281.0	17	106.5	29	177.5	46	284.0	114	565.0

Northern pike had the lowest mortality rate for gamefish taken in contract nets the first study year. Largemouth bass ranked next, and walleye and sauger were highest. The second year northern pike had the highest rate, followed by walleye. No sauger or largemouth bass mortality occurred the second year. Walleye mortality was higher than that for northern pike in Department nets. Panfish mortality varied over the range observed for gamefish with no particular species characteristics.

Seasonal Aspects of Mortality

Although more non-commercial fish were taken in spring and fall than during summer months, lower water temperatures tended to reduce mortality when catches were highest. The first study year, September, July, October and April were months of most significant non-commercial fish mortality. Only May had similar mortality in the second year.

The first year non-commercial fish other than northern pike made up a considerable portion of the total mortality, while the second year nearly all fish killed or injured were northern pike.

Absolute mortality for Department nets was highest in September, June, April and July. Probable mortality included the same months, plus May.

The number of injured fish was highest in spring and fall months, indicating better survival with lower water temperatures. Most injured fish would likely have been dead in the nets if taken during the warmer summer months. Most of the injured fish were northern pike.

Mortality by Location

Most non-commercial fish mortality in contract nets was located in the north and west central areas of the lower pool. The east central and south sections ranked next for the first study year, but had no mortality the second year. The upper and middle pool produced the lowest mortalities. Northern pike made up most of the mortality in all areas except the south section, where other gamefish were most numerous. Panfish mortality was located in the east and west central areas and sublegal catfish in the north and south sections.

Department net mortality was centered in the upper and middle pool areas.

The north section ranked next, followed by the west central area. Little mortality occurred in the east central area and none in the south. Northern pike made up a large part of the mortality in all areas except the south and east central. Panfish mortality appeared in the same areas as other than northern pike northern pike. Dead game fish were found in the upper pool and north and east central areas of the lower pool. The only dead sublegal catfish came from the east central area.

All waterfowl taken in contract and Department nets were dead, except for one canvasback released alive from a contract net in fall of the first year.

Non-Commercial Fish Mortality and Time Length of Set

Records were kept on the length of time nets were in the water before lifting to determine if this had any influence on non-commercial fish mortality. The shortest net sets were associated with "drive netting." This method of fish involves nets placed across the mouth of a shallow bay where a concentration of commercial fish has been located by their activity.

The fish are then chased into the net by making a loud disturbance at the water surface. The operation takes up to a few hours, and the nets are not left over night. Gamefish were seldom taken by this method and were easily released without injury when they were caught due to the short time in the net. This method is generally only effective during brief periods in the spring and fall months, and no mortality was observed in conjunction with it during the study.

It is usually advantageous to the commercial gill netter to run his nets after they have been set over night during the open water season. This is because after one night there will usually be enough fish in the nets to considerably reduce their efficiency if the catch is not removed. If not, relocation of the nets is probably desirable. Also, during hot weather part of the catch may die and spoil if left in the net more than one day. As a result, most contract net sets were over one night only. Longer sets usually occurred only when adverse weather conditions or insufficient hours of daylight prevented lifting. Nets set under the ice are often run less frequently as low water temperatures tend to decrease fish movement and therefore increase the time required to make an adequate catch while also reducing mortality and spoilage losses. In addition, more time is required to run the same amount of nets under the ice than in open water. Because the contracts produced no winter fishing and few open water sets over one day, Department nets set were frequently left for two or more days to evaluate the influence this might have on mortality.

Northern pike were the only gamefish taken in contract nets for which comparison between one day and longer sets was possible. The only gamefish other than northern pike taken in a set of two or more days duration was one sauger released alive. Northern pike mortality was higher for sets of two or more days than for one day, 60 percent and 20 percent, respectively. The only panfish that provided similar mortality comparisons was the crappie. The one-day set rate was 14 percent and the two or more day set rate was 33 percent. Other species furnished no comparisons.

For Department net sets, the northern pike mortality rate was lower for two or more day sets (30 percent) than for one-day sets (44 percent). Two walleyes taken in one-day sets were both killed, and one of two walleyes taken in longer sets died. Panfish mortality was higher for longer sets (83 percent) than for single day sets (50 percent). Longer sets produced no mortality for the other species taken.

In summary, gamefish and panfish mortalities did generally increase with increasing set length, although gamefish in Department nets were a notable exception.

ECONOMIC VALUE OF THE COMMERCIAL CATCH

The total value of the commercial fish taken under contract during the two-year study was \$16,136.00, \$9,200.83 the first year (57 percent), and \$6,935.17 the second (43 percent). Carp was again the dominant species, contributing \$11,050.55 or 68 percent of the total. Its overwhelming poundage more than compensated for its low value per pound (3 to 7 cents).

Buffalo ranked second at \$3,866.61 (24 percent) and varied from 6 cents to 20 cents per pound. Catfish came in a low third at \$967.36, only 6 percent despite their high value of 22 cents to 30 cents per pound. A low per pound value (5 cents to 10 cents) combined with a small catch, placed drum last with \$251.48, just 2 percent of the total. The catch value of each type of fish declined the second year and the percent of the total contributed by each species also changed. The significance of carp declined by the amount buffalo increased (3.5 percent). Drum increased slightly (0.3 percent) and catfish dropped slightly (0.1 percent).

Value by Month

Seasonally, the catch income was highest in April and September (17.4 percent each). June and July were about average months (12 and 13 percent, respectively). All remaining months ranged from 9.5 percent (August) to 10.5 percent (May). There was considerable variation in the seasonal distributions of the two years. The leading month in both years contributed just over 22 percent of the total annual income; September, 1970 and April 1972. Other months of above-average income the first year included November, April, and July, ranging from 14 to 13 percent. The second year the months of May, June, and July were above average (16 to 13 percent). Slightly below average months (10 to 12 percent) included October and June the first year and August and September the second. Low income months the first year were August (8 percent) and May (6 percent), and October (8 percent) and November (4 percent) the second. In summary, April was consistently highest in annual income production. September ranked high one year but was below average the next. May and November fluctuated most widely between high and low income. June also ranged from above to below average, but not with as wide a variation. July was consistently slightly above average and August and October below.

The distribution of the income between the major species seasonally was also examined. Carp were practically the entire source of income in November, the remaining 1 to 2 percent from buffalo. They were also quite dominant during April, September and October (70 to 80 percent). Their importance declined during late spring and late summer (55 to 65 percent for May, June, and August), and was lowest in July (just under 50 percent). Buffalo were most significant during the summer months, contributing 30 to 40 percent of the monthly income June through August, with the peak in July. May and October followed (25 to 26 percent). April and September made up the remaining months of significant buffalo catches (19 percent each). Drum made the greatest contribution of their small fraction of the total income in July and August (3 percent). October and June ranked next (2 percent) with May and September following (1.0 percent). Drum were insignificant in the cold water months of April and November (less than 0.5 percent). Catfish catches were most significant from May through August (9 to 12 percent), peaking in July. Transitional months of April and September showed marked declines (3 to 4 percent), and fall was insignificant, 1.5 percent or less in October and November.

Annual fluctuations in the economic significance of the major commercial species were also examined. The value of the carp catch showed the greatest variation in April and May, followed closely by June and October (range, 18 to 15 percent of the total catch value). Buffalo values fluctuated most in April, June, and October, 12 to 13 percent of the total catch value. The value of the catfish catch varied 14 percent in May. Catfish catch values in the remaining months and drum values in all months varied less than 5 percent.

Value by Location

The west central and north sections of the lower pool produced just over half the total income (27 and 24 percent, respectively). The east central and south followed with just under one-third (17 and 13 percent, respectively). The smallest producers were the upper and mid-pool areas (12 and 5 percent, respectively). On an annual basis, the west central section of the lower pool led with one-third of the 1970-71 income but was replaced by the north section the second year (39 percent). Both areas were above average both years. The east central and south sections were big producers the first year (21 to 9 percent). The upper pool jumped from the poorest area (under 8 percent) in 1970-71 to well above average (19 percent) in 1971-72. The mid-pool was the consistently poorest area, with just over 8 percent the first year and only 1 percent the second.

Carp dominated the catch income from the mid-pool area most heavily (94 percent), followed by the west central (87 percent). The north and upper pool sections were similar (68 to 70 percent), and carp were least influential in the east central (51 percent) and south (41 percent) sections. The significance of buffalo was negatively correlated to that of carp, being highest where carp was lowest and vice versa. Buffalo (39 to 46 percent), drum (2 to 3 percent), and catfish (9 to 14 percent) were all most prominent in the east central and south sections. For Buffalo and catfish, the north and upper pool sections ranked next, with west central and mid-pool lowest. The upper and mid-pool areas brought the lowest drum income, with the north and west central intermediate.

Annual fluctuations in the economic importance of the major commercial species in the six areas were noted. The significance of carp and buffalo varied most in the east central area, between 15 and 20 percent of the total catch value. Catfish catch values fluctuated most (4 to 6 percent of the total catch value) in the upper pool, and north and south areas. Drum catches fluctuated less than 2 percent in all areas. The middle pool and west central areas where carp dominated most heavily showed the smallest annual fluctuations.

COMPARISONS BETWEEN THE COMMERCIAL CATCH AND THE NON-COMMERCIAL CATCH

To aid in evaluating the gill net fishery, the commercial and non-commercial catches and their values were compared.

Commercial Catch Rate per Non-Commercial Fish and Waterfowl

1. The pounds of commercial fish were compared to the numbers and weight of non-commercial fish taken, obviously injured, and dead in the nets.
2. The carp portion of the commercial catch was also compared, as this species is not likely to have an adverse effect on sport fish populations. For all contract and Department netting during the entire study, the commercial catch per non-commercial fish ranged from 1,000 to 4,000 pounds depending on the degree of mortality (Table 11a). The rate per pound of non-commercial fish ranged from 200 to 900 pounds of commercial fish. Contract nets produced commercial catch rates several times larger than those for Department nets. Annual variation in the rates ranged up to 40 percent of the two-year mean for contract nets and 60 percent for Department nets. Rates for the more significant non-commercial fish species and groups of species are given in Tables 11b -11d.

The commercial harvest per duck was 1,200 pounds for the fall migration and 22,000 pounds for the spring migration (Table 11e). Commercial catch rates for contract nets were several times higher than those for Department nets. Rates varied widely between the two study years.

Table 11a. Pounds of Commercial Fish and Carp Taken Per Non-Commercial Fish
(by number and pounds) Caught, Killed or Injured, and Killed.
May 1970 - April 1972.

	Per Non-Commercial Fish Caught		Per Non-Commercial Fish Killed or Injured		Per Non-Commercial Fish Killed	
	Per Fish	Per Pound	Per Fish	Per Pound	Per Fish	Per Pound
<u>CONTRACT NETS</u>						
<u>1970-71</u>						
Commercial Fish	1,137	238	4,030	1,058	5,373	1,576
Carp only	1,003	210	3,555	934	4,741	1,391
<u>1971-72</u>						
Commercial Fish	1,583	342	5,674	1,200	6,809	1,548
Carp only	1,361	294	4,876	1,031	5,852	1,330
<u>Both Years</u>						
Commercial Fish	1,295	274	4,610	1,116	5,915	1,563
Carp only	1,130	239	4,022	973	5,160	1,364

<u>DEPARTMENT NETS</u>						
<u>1970-71</u>						
Commercial Fish	247	39	349	56	742	91
Carp only	213	33	301	48	640	78
<u>1971-72</u>						
Commercial Fish	157	25	297	49	431	97
Carp only	122	19	232	38	337	76
<u>Both Years</u>						
Commercial Fish	184	29	317	51	520	95
Carp only	150	24	258	42	423	77

<u>Contract and Department Nets - Both Years</u>						
Commercial Fish	1,022	200	2,878	581	4,050	925
Carp only	889	174	2,503	505	3,523	805

Table 11b. Pounds of Commercial Fish and Carp Taken Per Game Fish (by number and pounds) Caught, Killed or Injured, and Killed,
May 1970 - April 1972

	Per Game Fish Caught		Per Game Fish Killed or Injured		Per Game Fish Killed	
	Per Fish	Per Pound	Per Fish	Per Pound	Per Fish	Per Pound
<u>CONTRACT NETS</u>						
<u>1970-71</u>						
Commercial Fish	1,515	270	4,546	1,081	6,114	1,619
Carp only	1,337	238	4,011	954	5,394	1,429
<u>1971-72</u>						
Commercial Fish	2,128	379	5,921	1,232	6,809	1,548
Carp only	1,829	326	5,088	1,059	5,852	1,330
<u>Both Years</u>						
Commercial Fish	1,732	309	5,056	1,142	6,398	1,587
Carp only	1,511	269	4,411	996	5,581	1,385

<u>DEPARTMENT NETS</u>						
<u>1970-71</u>						
Commercial Fish	297	46	371	56	742	91
Carp only	256	40	320	49	640	78
<u>1971-72</u>						
Commercial Fish	210	27	392	50	664	103
Carp only	164	21	306	39	518	81
<u>Both Years</u>						
Commercial Fish	239	32	383	52	693	98
Carp only	194	26	312	43	564	80

<u>Contract and Department Nets - Both Years</u>						
Commercial Fish	1,356	223	3,280	594	4,686	947
Carp only	1,179	194	2,853	516	4,076	823

Table 11c. Pounds of Commercial Fish and Carp Taken Per Northern Pike (by number and pounds) Caught, Killed or Injured, and Killed,
May 1970 - April 1972

	Per Northern Pike Caught		Per Northern Pike Killed or Injured		Per Northern Pike Killed	
	Per Fish	Per Pound	Per Fish	Per Pound	Per Fish	Per Pound
<u>CONTRACT NETS</u>						
<u>1970-71</u>						
Commercial Fish	1,866	298	6,567	1,328	9,850	2,074
Carp only	1,133	263	5,794	1,172	8,691	1,830
<u>1971-72</u>						
Commercial Fish	2,619	443	6,485	1,329	7,566	6,502
Carp only	2,251	381	5,573	1,142	1,702	1,463
<u>Both Years</u>						
Commercial Fish	2,133	348	6,531	1,328	8,708	1,894
Carp only	1,860	303	5,697	1,159	7,596	1,652

<u>DEPARTMENT NETS</u>						
<u>1970-71</u>						
Commercial Fish	312	49	396	61	848	102
Carp only	269	42	341	52	731	88
<u>1971-72</u>						
Commercial Fish	227	27	431	53	784	117
Carp only	177	21	337	41	612	91
<u>Both Years</u>						
Commercial Fish	255	33	416	56	809	110
Carp only	208	27	339	45	658	90

<u>Contract and Department Nets - Both Years</u>						
Commercial Fish	1,608	245	3,952	660	6,075	1,103
Carp only	1,399	213	3,438	574	5,284	959

Table 11d. Pounds of Commercial Fish and Carp Taken Per Panfish (by number and pounds) Caught, Killed or Injured, and Killed.

May 1970 - April 1972

	Per Panfish Caught		Per Panfish Killed or Injured		Per Panfish Killed	
	Per Fish	Per Pound	Per Fish	Per Pound	Per Fish	Per Pound
<u>CONTRACT NETS</u>						
<u>1970-71</u>						
Commercial Fish	11,820	16,886	44,324	70,919	59,099	88,649
Carp only	10,429	14,899	39,110	62,575	52,146	78,219
<u>1971-72</u>						
Commercial Fish	13,618	13,618	No panfish killed or Injured			
Carp only	11,704	11,704				
<u>Both Years</u>						
Commercial Fish	12,539	15,292	78,370	125,391	104,493	156,739
Carp only	10,939	13,340	68,368	109,389	91,158	136,736

<u>DEPARTMENT NETS</u>						
<u>1970-71</u>						
Commercial Fish	5,934	5,934	5,934	5,934	No panfish killed	
Carp only	5,118	5,118	5,118	5,118		
<u>1971-72</u>						
Commercial Fish	1,232	2,157	1,438	2,876	1,438	2,876
Carp only	962	1,683	1,122	2,244	1,122	2,244
<u>Both Years</u>						
Commercial Fish	1,820	2,912	2,080	3,640	2,427	4,854
Carp only	1,481	2,370	1,693	2,963	1,975	3,950

<u>Contract and Department Nets - Both Years</u>						
Commercial Fish	9,941	12,864	29,822	50,468	36,449	65,608
Carp only	8,646	11,189	25,939	43,896	31,703	57,065

Table 11e. Pounds of Commercial Fish and Carp Taken Per Duck Caught in Contract and Department Nets, May 1970 - April 1972.

	CONTRACT NETS			DEPARTMENT NETS			COMBINED NETS		
	Scaup	Canvas-back	All Ducks	Scaup	Canvas-back	All Ducks	Scaup	Canvas-back	All Ducks
<u>Fall 1970</u>									
Commercial Fish	5,050	4,591	2,104	200	-	200	2,753	4,755	1,585
Carp	4,820	4,382	2,008	200	-	200	2,632	4,545	1,515
<u>Spring 1971</u>									
Commercial Fish	No ducks			1,900	-	1,900	31,100	-	31,100
Carp				1,600	-	1,600	28,800	-	28,800
<u>1970-71 Fall and Spring Combined</u>									
Commercial Fish	7,970	7,245	3,321	370	-	370	4,170	7,582	2,453
Carp	7,540	6,855	3,142	340	-	340	3,940	7,164	2,318
<u>Fall 1971</u>									
Commercial Fish	710	-	687	No ducks			748	-	723
Carp	686	-	663				724	-	700
<u>Spring 1972</u>									
Commercial Fish	17,000	-	17,000	No ducks			17,100	-	17,000
Carp	14,350	-	14,350				14,450	-	14,450
<u>1971-72 Fall and Spring Combined</u>									
Commercial Fish	1,761	-	1,706	No ducks	-		1,803	-	1,747
Carp	1,568	-	1,519				1,610	-	1,559
<u>Fall 1970-71</u>									
Commercial Fish	1,823	6,464	1,317	322	-	322	1,542	6,727	1,175
Carp	1,746	6,191	1,261	322	-	322	1,479	6,455	1,127
<u>Spring 1971-72</u>									
Commercial Fish	31,600	-	31,600	2,100	-	2,100	21,767	-	21,767
Carp	27,950	-	27,950	1,800	-	1,800	19,233	-	19,233
<u>Fall and Spring 1970-72</u>									
Commercial Fish	3,276	12,209	2,398	500	-	500	2,731	12,664	2,111
Carp	3,024	11,273	2,214	470	-	470	2,524	11,700	1,950
<u>1970-71 All Months</u>									
Commercial Fish	17,730	16,118	7,387	593	-	593	9,162	16,657	5,389
Carp	15,644	14,222	6,518	512	-	512	8,078	14,687	4,752
<u>1971-72 All Months</u>									
Commercial Fish	4,393	-	4,256	No ducks			4,671	-	4,525
Carp	3,775	-	3,657				3,993	-	3,868
<u>1970-72 All Months</u>									
Commercial Fish	7,646	28,498	5,598	1,456	-	1,456	6,432	29,822	4,970
Carp	6,670	24,861	4,883	1,185	-	1,185	5,595	25,939	4,323

Commercial Value Rate per Non-Commercial Fish and Waterfowl

The value of the commercial catch in contract and Department nets for the entire study ranged from \$50 to \$200 per loss of non-commercial fish and \$10 to \$50 per pound of non-commercial catch, varying with the degree of mortality (Table 12a). Contract net rates ranged from \$60 to \$350 per non-commercial fish and \$12 to \$80 per pound of non-commercial fish. Department net rates were considerably lower, \$15 to \$35 per fish and \$2 to \$8 per pound. Value rates for the more significant individual species and groups of species are given in Tables 12b.- 12d. The value of the commercial catch per duck taken during fall migration period was \$54 and \$1,000 during the spring migration (Table 12e). Contract net values were three times those for Department nets in the fall, and over 12 times Department net values in the spring.

COMPARISONS BETWEEN COMMERCIAL AND NON-COMMERCIAL CATCH VALUES

In an attempt to assign a monetary value to sport fish and waterfowl losses, data from the 1970 National Survey of Hunting and Fishing on estimated sportsmen's expenditures per trip were combined with creel census and duck bag check data on fish and duck harvest rates in the Pool 7 area collected in Department field surveys. Value comparisons for potential mortality (all netted sport fish and ducks assumed killed) found the commercial fish taken in contract nets had a market value about six times that of the sport fish and ducks taken (Table 13a). For Department nets, the value of the commercial catch was 1.1 to 1.3 times higher than the non-commercial catch. For probable mortality, the commercial to sport catch ratio increased to 12 to 15 times for contract nets and 1-1/4 to 2-1/2 times for Department nets (Table 13b). The ratios were slightly higher for absolute mortality (only fish and ducks dead in the nets counted): 13 to 19 times for contract nets, and 2 to 4 times for Department nets (Table 13c).

Table 12a. Value of Commercial Catch Per Non-Commercial Fish (by number and pounds) (in dollars) Caught, Killed or Injured, and Killed.
May 1970 - April 1972

	Per Non-Commercial Fish Caught		Per Non-Commercial Fish Killed or Injured		Per Non-Commercial Fish Killed	
	Per Fish	Per Pound	Per Fish	Per Pound	Per Fish	Per Pound
<u>CONTRACT NETS</u>						
1970-71	58.98	12.34	209.11	54.93	278.81	81.79
1971-72	80.64	17.40	288.97	61.10	346.76	78.81
Both Years	66.68	14.10	237.29	57.42	304.45	80.48
<u>DEPARTMENT NETS</u>						
1970-71	15.64	2.44	22.07	3.52	46.91	5.73
1971-72	12.54	2.00	23.79	3.89	34.49	7.79
Both Years	13.48	2.14	23.15	3.75	38.04	6.92
Contract and Department Nets - Both Years	53.59	10.47	150.89	30.44	212.36	48.52

Table 12b. Value of Commercial Catch (in dollars) Per Game Fish (by number and pounds) Caught, Killed or Injured, and Killed.
May 1970 - April 1972

	Per Game Fish Caught		Per Game Fish Killed or Injured		Per Game Fish Killed	
	Per Fish	Per Pound	Per Fish	Per Pound	Per Fish	Per Pound
<u>CONTRACT NETS</u>						
1970-71	78.64	14.03	235.92	56.10	317.27	84.03
1971-72	108.36	19.29	301.53	62.76	346.76	78.81
Both Years	89.15	15.89	260.26	58.78	329.31	81.70
<u>DEPARTMENT NETS</u>						
1970-71	18.76	2.91	23.45	3.56	46.91	5.73
1971-72	16.82	2.13	31.35	4.00	53.06	8.26
Both Years	17.46	2.35	28.03	3.83	50.72	7.15
Contract and Department Nets - Both Years	71.08	11.72	172.01	31.13	245.73	49.64

Table 12c. Value of Commercial Catch (in dollars) Per Northern Pike (by number and pounds) Caught, Killed or Injured, and Killed.
May 1970 - April 1972

	Per Northern Pike Caught		Per Northern Pike Killed or Injured		Per Northern Pike Killed	
	Per Fish	Per Pound	Per Fish	Per Pound	Per Fish	Per Pound
<u>CONTRACT NETS</u>						
1970-71	96.85	15.49	340.77	68.92	511.16	107.61
1971-72	133.37	22.55	330.25	67.66	385.29	86.69
Both Years	109.77	17.90	336.17	68.37	448.22	97.50
<u>DEPARTMENT NETS</u>						
1970-71	19.75	3.11	25.02	3.83	53.61	6.47
1971-72	18.15	2.19	34.49	4.23	62.70	9.32
Both Years	18.68	2.45	30.43	4.08	59.17	8.07
Contract and Department Nets - Both Years	84.32	12.87	207.24	34.61	318.54	57.82

Table 12d. Value of Commercial Catch (in dollars) Per Panfish (by number and pounds) Caught, Killed or Injured, and Killed
May 1970 - April 1972

	Per Panfish Caught		Per Panfish Injured or Killed		Per Panfish Killed	
	Per Fish	Per Pound	Per Fish	Per Pound	Per Fish	Per Pound
<u>CONTRACT NETS</u>						
1970-71	613.39	876.27	2,300.21	3,680.33	3,066.94	4,600.42
1971-72	693.52	693.52	No panfish injured or killed			
Both Years	645.44	787.12	4,034.00	6,454.40	5,378.67	8,068.00
<u>DEPARTMENT NETS</u>						
1970-71	375.27	375.27	375.27	375.27	No panfish killed	
1971-72	98.54	172.44	114.96	229.92	114.96	229.92
Both Years	133.13	213.01	152.15	266.26	177.51	355.01
Contract and Department Nets - Both Years	521.24	674.55	1,563.73	2,646.31	1,911.23	3,440.21

Table 12e. Value of Commercial Catch (in dollars) Per Duck Caught in Contract and Department Nets. May 1970 - April 1972

	CONTRACT NETS			DEPARTMENT NETS			COMBINED NETS		
	Scaup	Canvas-back	All Ducks	Scaup	Canvas-back	All Ducks	Scaup	Canvas-back	All Ducks
Fall 1970	236.64	215.12	98.60	11.77	-	11.77	130.12	224.76	74.92
Spring 1971	-	-	-	89.62	-	89.62	1,361.84	-	1,361.84
Spring and fall 1971-72	363.86	330.78	151.61	19.56	-	19.56	191.71	348.56	112.77
Fall 1971	29.57	-	28.58	-	-	-	32.10	-	31.03
Spring 1972	768.25	-	768.25	-	-	-	778.54	-	778.54
Spring and fall 1971-72	77.22	-	74.81	-	-	-	80.25	-	77.75
Fall 1970-71	82.66	293.07	59.70	19.92	-	19.92	70.90	309.37	54.02
Spring 1971-72	1,404.36	-	1,404.36	110.20	-	110.20	972.97	-	972.97
Fall and spring 1970-72	147.13	548.41	107.72	28.95	-	28.95	123.96	574.73	95.79
1970-71 All Months	920.08	836.44	383.37	37.53	-	37.53	478.80	870.55	281.65
1971-72 All Months	223.72	-	216.72	-	-	-	245.97	-	238.28
1970-72 All Months	393.56	1,466.91	288.14	106.50	-	106.50	337.28	1,563.73	260.62

Table 13a

COMPARISON OF VALUE (IN DOLLARS) OF COMMERCIAL CATCH AND SPORT CATCH (FISH AND WATERFOWL)
IN CONTRACT AND DEPARTMENT NETS - May 1970 - April 1972.

	CONTRACT NETS			DEPARTMENT NETS		
	1970-71	1971-72	Both Years	1970-71	1971-72	Both Years
Northern Pike	1,273.00	696.80	1,969.80	254.60	509.20	763.80
Walleye-Sauger	72.42	46.86	119.28	4.26	12.78	17.04
Largemouth Bass	41.45	8.29	49.74	-	-	-
Panfish	22.95	15.30	38.25	1.53	10.71	12.24
Sport fish Total	1,409.82	767.25	2,177.07	260.39	532.69	793.08
Waterfowl	212.40	283.20	495.60	88.50	-	88.50
Sport Fish and Waterfowl Total	1,622.22	1,050.45	2,672.67	348.89	532.69	881.58
Commercial Value	9,200.83	6,935.17	16,136.00	375.27	689.77	1,065.04
Cost/ Benefit Ratio	5.67/ 1.00	6.60/ 1.00	6.04/ 1.00	1.08/ 1.00	1.29/ 1.00	1.21/ 1.00

1. Based on data from "The 1967 - 1968 Sport Fisher Survey of the Upper Mississippi River," "1971 Upper Mississippi Refuge Duck Hunting and Harvest Summary," and "1970 National Survey of Fishing and Hunting."

Table 13b

COMPARISON OF VALUE (IN DOLLARS) OF COMMERCIAL CATCH AND SPORT FISH KILLED OR INJURED AND WATERFOWL KILLED IN CONTRACT AND DEPARTMENT NETS - May 1970 - April 1972.

	CONTRACT NETS			DEPARTMENT NETS		
	1970-71	1971-72	Both Years	1970-71	1971-72	Both Years
Northern Pike	361.80	281.40	643.20	201.00	268.00	469.00
Walleye-Sauger	42.60	8.52	51.12	4.26	8.52	12.78
Largemouth Bass	16.58	-	16.58	-	-	-
Panfish	6.12	-	6.12	1.53	9.18	10.71
Sportfish Total	427.10	289.92	717.02	206.79	285.70	492.49
Waterfowl	203.55	283.20	486.75	88.50	-	88.50
Sportfish and Waterfowl Total	630.65	573.12	1,203.77	295.29	285.70	580.99
Commercial Fish	9,200.83	6,935.17	16,136.00	375.27	689.77	1,065.04
Cost/ Benefit Ratio	14.59/ /1.00	12.10/ /1.00	13.40/ /1.00	1.27/ /1.00	2.41/ /1.00	1.83/ /1.00

Table 13c

COMPARISON OF VALUE (IN DOLLARS) OF COMMERCIAL CATCH AND SPORT FISH AND WATERFOWL KILLED IN CONTRACT AND DEPARTMENT NETS - May 1970 - April 1972.

	CONTRACT NETS			DEPARTMENT NETS		
	1970-71	1971-72	Both Years	1970-71	1971-72	Both Years
Northern Pike	241.20	241.20	482.40	93.80	147.40	241.20
Walleye-Sauger	17.04	8.52	25.56	4.26	8.52	12.78
Largemouth Bass	8.29	-	8.29	-	-	-
Panfish	4.59	-	4.59	-	9.18	9.18
Sportfish Total	271.12	249.72	520.84	98.06	165.10	263.16
Waterfowl	203.55	283.20	486.75	88.50	-	88.50
Sport fish and Waterfowl Total	474.67	532.92	1,007.59	186.56	165.10	351.66
Commercial Value	2,200.83	6,935.17	16,136.00	375.27	689.77	1,065.04
Cost / Benefit Ratio	19.38 / 1.00	13.01 / 1.00	16.01 / 1.00	2.01 / 1.00	4.18 / 1.00	3.03 / 1.00

SUMMARY

A two-year study of commercial gill netting in Pool 7 involved one-half million feet of net annually (90 percent under contract and 10 percent by Department personnel). An annual contract catch of approximately 150,000 pounds of commercial fish (almost 90 percent carp, 10 percent buffalo, and small amounts of drum and catfish) valued at \$7,000 to \$9,000 also included from 90 to 150 non-commercial fish (390 to 760 pounds) and 25 to 30 diving ducks. Department net catch rates were one-half those of contract nets for commercial fish, but 3 to 4 times as high for non-commercial fish and one-third higher for ducks. The non-commercial fish taken were mainly northern pike, with smaller numbers of other gamefish, panfish, and sublegal catfish making up the remainder. Three-fourths of the ducks were scaup, and most of the remainder canvasback.

The distribution of contract fishing effort, the commercial catch and its value, and the non-commercial fish taken and their mortality indicate the significance particular areas and months would have in a gill net fishery similar to the one in the study.

Half the contract fishing the first year of the study was done in the east and west central areas, with equal amounts in each. The north and south areas also received equal amounts of effort, together one-third of the total. The west central area had the highest commercial catch and value and non-commercial catch and mortality. The east central area ranked second in commercial catch and value, and the south area was second in non-commercial catch and mortality. The second year the north area dominated the fishery in all statistical areas, followed by the west central area and upper pool. For both years combined effort was about equally

distributed between the three leading areas, the west central, east central, and north. The west central area led in commercial catch and value, followed by the north, and east central. The non-commercial catch came mainly from the west central, north and upper pool areas, with most of the dead and injured sport fish from the west central and north areas.

The heaviest fished month the first year was September, followed by October and July. September, April, and November equally shared the highest commercial catch. The most valuable catch was taken in September, with April and November equal in second place. April had the highest non-commercial catch, with September, October and November equally ranking second. Four months had important amounts of sport fish mortality. September and July were highest in dead fish and October and April when injured fish were also included.

High monthly fishing effort the second year was quite uniformly distributed from May through September, with July and September slightly higher than the other three months. April dominated the commercial catch and value followed by May and June. May was the dominant month for non-commercial catch and mortality. Appreciable numbers of sport fish also occurred in April, July and September, and mortality in June, August and September.

For both years combined, fishing effort was highest in September, followed by July and October. April dominated the commercial catch followed by September, and both equal as top value months. April produced the largest number of non-commercial fish, with significant amounts in May, September and October. Dead sport fish occurred most frequently in September, followed by October and July. The leading month when injured fish were also included was October, followed closely by September, April and May.

Fishing during the fall duck migration period (October, November) was centered in the north and west central areas, about equally in each. Most of the commercial catch and its value came from the west central area, and most of the ducks from the north area. The fishing effort, commercial catch and value, during the spring migration (April) was about equally distributed between the upper pool and west central area the first year, and mainly in the upper pool the second year. All ducks caught in the spring came from the upper pool. The number of ducks taken during the fall migration was far higher than during the spring migration. Duck mortality was nearly 100 percent.

Catch rates of commercial and non-commercial fish and waterfowl by month and area indicate how the gill net fishery is likely to be affected by changing the distribution of fishing effort with respect to season and location.

Highest catch and value rates for commercial fish in contract nets both years occurred in April and November, followed by May and June. April led in the catch rate of non-commercial fish, followed by November and October the first year and November and May the second. Dead sport fish occurred at the highest rates the first year in April and July, followed by August and September. The second year the rate was highest in May, followed by November and August. When injured fish were also included, April had the highest rate the first year followed by October. The second year the highest mortality occurred in May, followed by November. For both years combined April had the highest catch rate for non-commercial fish, followed by November and May. The death rate was highest in May, with

similar lower rates in all the other months except for a much lower rate in November. May, April and October were the leading months when injured sport fish were included.

Department nets were fished only during the last half of the first study year. Highest commercial fish catch rates were made in September and October, followed by April. September had the highest value rate, followed by October and April. The occurrence of non-commercial fish was much higher in April than the other three months. Dead sport fish appeared at the highest rate in April, followed by September.

The second year, January had the highest commercial fish catch rate, and July and June were the top open water months. January and March had the highest value rates, and the highest open water rates occurred in August and June. April had a far higher catch rate for non-commercial fish than any other month, with fishing under the ice (January through March) ranking next. November had the highest death rate, with four months ranking next (April, June, July and September). When injured sport fish were included, April was far above all other months in sport fish mortality, with November and February next.

Of the four months fished in both years, commercial catch and value were similarly high in April, September and October, with November low. The rate of occurrence of gamefish and their injury and death was much higher in April than the other three months. April also was highest in sport fish dead in the nets, but the other months were only slightly lower.

The west central area had the highest contract commercial catch and value rate the first year, followed by the upper and middle pool. The catch rate for non-commercial fish was considerably higher in the upper pool than the other areas, with the west central and middle pool next. The middle pool had the highest rate of death and injury of sport fish. All other areas were slightly lower, except for a much lower rate in the east central area. The highest rate for dead sport fish in the nets occurred in the south area, closely followed by the middle pool and north area. The upper pool led in commercial and non-commercial catch and value rates the second year, followed by the west central and north areas. Sport fish mortality was highest in the west central area, followed by the north section.

For both years combined, the upper pool ranked first in commercial catch and value rates, followed closely by the west central area. Non-commercial catch rates were considerably higher in the upper pool than the other areas, followed by the west central and middle pool areas. The occurrence of dead or injured sport fish was highest in the west central and middle pool areas. The west central area also ranked first in dead sport fish, closely followed by the north and south sections.

Commercial catch and value rates for Department nets the first year were considerably higher in the north area than any other location. The west central area ranked second in commercial catch rates and the south area second in value rates. The non-commercial catch and death or injury rates were highest in the middle pool, with the upper pool next. The occurrence of dead sport fish was highest in the upper pool, followed by the north area and middle pool.

The second year the upper pool was far above all other areas in the commercial catch rate for Department nets. Similar rates in the south, north, and middle pool areas ranked next. The south area had the highest value rate followed by the upper pool. Non-commercial catch and death or injury rates were much higher in the upper pool than for any other area. The middle pool and north areas ranked next. The upper pool also lead in the occurrence of dead sport fish in the nets, followed by the north section, with the middle pool and west central areas both ranking third. For both years combined, the commercial catch rate for Department nets was highest in the upper pool, followed by the west central area. The highest value rate came from the south area, with the north area second. Non-commercial catch and death or injury rates were highest in the upper pool followed by the middle pool and north area. Dead sport fish **appeared** at the highest rate in the north area, with the upper pool and middle pool close behind.

During the first fall duck migration in the study, the west central area ranked first in the contract commercial catch and value rates, with the middle pool second. Duck catch rates were highest in the south area, followed by the north area. The west central area also **led** in the rate of commercial catch and value the second fall, with the north area a close second. A very high duck catch rate in comparison to the first fall occurred in the north area. All other areas produced no ducks, except for one taken in the west central area. For both falls combined, the west central area was first in commercial catch and value, with the middle pool and north sections next. The north area had the highest duck catch rate, with the south area second.

The Department net commercial catch and value rates were highest and about equal in the middle pool and west central areas the first fall.

Ducks were taken at a high rate in the east central area, and in that area only. The second fall, the west central area led the commercial catch and value rates, followed by the south area. No ducks were taken. Department nets were fished both falls in the west central area only, which produced a high commercial catch and value rate, and no waterfowl.

Contract netting during the spring waterfowl migration the first year yielded extremely high commercial catch and value rates in the middle pool and high rates in the west central and upper pool areas. No waterfowl were taken. The second year, commercial catch and value rates were very high in the north and west central areas, and high in the upper and middle pool areas. Ducks were taken only in the upper pool, and at a low rate there. High commercial catch and value rates in the three areas fished both years corresponded to a low duck catch rate in the upper pool only.

Department net commercial catch and value rates were highest in the upper pool the first spring and the middle pool the second spring. Ducks were taken in the upper pool during the first spring only, at a rate above the spring contract rate and below the leading fall contract rates.

The value of sport fish and waterfowl lost through commercial gill netting based on surveys of hunting and fishing expenditures amounted to from 5 to 20 percent of the market value of the commercial contract catch, varying with the annual mortality rate assumed. Sport fish and waterfowl losses in Department nets were considerably more significant, from 25 to 95 percent of the saleable commercial catch in terms of monetary value.

DISCUSSION AND CONCLUSIONS

The results of a two-year investigation of commercial gill netting on one Mississippi River pool indicates that certain losses of non-commercial fish (chiefly northern pike) and waterfowl (chiefly scaup and canvasback) are a definite consequence of this fishery. The magnitude of these losses does not appear to be sufficient to justify maintaining the complete closure of the study area which existed for seven years prior to this study. However, the annual amount of fishing effort during the study was only half of the annual average for the 10 years prior to closure. The two years immediately prior to closure had effort 3 to 5 times that expended during the study years. The annual commercial catch under contract was about the same as the mean catch for the ten years prior to closure, with only one year having considerably larger annual catch than those during the study. Therefore, gill net efficiency was higher during the study period than during any of the ten years prior to closure. Comparable gill netting by Department personnel yielded commercial fish with only half the efficiency of contract netting. However, catch rates for non-commercial fish were 3 to 4 times higher in Department than contract nets, and waterfowl rates were one-third higher in Department nets. This indicates a selectivity for commercial fish and against non-commercial fish by contract fishermen. If the gill net fishery were to revert to its former pre-closure status, with commercial catch efficiency dropping to pre-closure levels, the catch of commercial fish per non-commercial fish and waterfowl would be considerably lower than during the study period. The difference in efficiency between an exploited and unexploited commercial fish population could result from reduced numbers and/or altered behavior patterns of commercial fish of susceptible size.

Another potential cause is the influence of location. It is probable that, with the low fishing pressure during the study, netting could be conducted in those areas where efficiency was greatest. With an expanded fishery, less productive areas would have to be entered. Close supervision by Department personnel during the study encouraged contract fishermen to avoid areas with high non-commercial and waterfowl catch rates. The absence of supervision and increased pressure could encourage expansion of the fishery into areas of higher non-commercial and waterfowl catch rates. The term "area" here is not equivalent to one of the six study areas. Nets set at different locations within a study area often varied considerably in the species composition of the catch, and catches at a given location changed considerably with fish movements. In summary, the probability of an optimum ratio of commercial to non-commercial catch declines with an expanding fishery.

The mean catch rate for commercial gill netting for the ten years prior to the closure of Pool 7 was identical to that for Department nets during the study. While there is no means of determining the non-commercial fish and waterfowl catches during the pre-closure period, if the catch rates for non-commercial fish and waterfowl then were also similar to those for Department nets during this study, the value of the non-commercial fish and waterfowl would represent a sizable fraction of the market value of the commercial harvest. If a gill net fishery were to become re-established with catch rates more closely resembling those for Department nets than contract nets during the study, and of a size comparable to that of 1962 and 1963, sport fish and duck losses could increase to a level sufficient to produce a reaction on the part of sportsmen similar to that leading to the 1964 closure. Some method of regulating the gill net fishery

to keep non-commercial and waterfowl losses within limits tolerable to sporting interests while also providing for utilization of the commercial resource would appear to be the best management approach.

Possible means of control include regulation of the amount of gear licensed, the areas fished, the months fished, fishing methods, and spot checks during the most critical periods. A fishery similar to that during the study period which resulted in commercial harvest levels comparable to the pre-closure period without excessive gamefish and waterfowl losses could be maintained by limiting the number of fishermen (issuing a prescribed number of contracts) or the amount of gear licensed, or both. Closing key areas and months could substantially reduce gamefish and waterfowl losses, but would reduce the commercial catch to about the same extent. Controls on effort in the areas and/or during the months of highest non-commercial catches would be more conducive to sizable commercial harvest without problem gamefish losses. For example, the upper pool is almost entirely spring fishery, and would in effect completely close if fishing there were not allowed in April and May. A method of gill netting known as "drive-netting" provides an effective means of making large commercial catches under certain conditions during spring and fall months, with no threat to non-commercial fish or waterfowl. When heavy concentrations of commercial fish (carp or buffalo) can be located in a shallow bay that can be effectively blocked with nets, and the fish can be frightened into the nets by creating a disturbance in the area, this method is often employed. Gamefish are seldom taken under these circumstances, and because all fish are removed shortly after capture, the possibility of serious injury is negligible. Restricting gill netting to daylight hours only during spring and fall months

would nearly eliminate gamefish and waterfowl mortality then. Spot checking could be conducted during critical months, in critical areas, or in any unusually heavy concentration of gill netting effort. This could be done to enforce formal netting restrictions, or on the basis that nets be removed or moved to another location only if and when problem situations develop. Spot checks would also be a useful means of detecting and rectifying problem situations before adverse public opinion developed. Observations of contract and Department netting during the fall waterfowl migration indicates that duck losses could be practically eliminated by setting nets in shallow bays near the shoreline, and avoiding open water areas. The near-shore areas are used heavily by dabbling ducks which, unlike the divers located in more open water, are apparently not susceptible to gill nets.

One conflict between gill netting and other interests arose during the study which forced the termination of data collection in the eastern half of the south study area after the first year. This area is heavily used for sport fishing from late spring through early fall, and for ice fishing in the winter months. Setlining is prohibited in the area, and gill net catches of flathead catfish during the study aroused jealousy on the part of setliners. Sport fishermen complained of gill nets interfering with their activities. The first year's data collected indicated the area had potential for good commercial fish harvest in spring and fall months, with sport fish catches no higher than other pool areas. The results of fishing this area indicate the importance of regulating gill netting to minimize conflicts with other uses of a given pool area, since the problem here was not even related to sport fish or waterfowl losses.

ACKNOWLEDGEMENTS

The following personnel of the Wisconsin Department of Natural Resources contributed to the planning and successful completion of the Pool 7 gill netting study:

Ronald J. Poff	Supervisor, Boundary Waters and Great Lakes Fisheries
Willis B. Fernholz	Area Fish Manager
Kenneth J. Wright	Mississippi River Biologist

The following personnel were involved in the collection and summarizing of field data:

Vernon Crawley	Conservation Technician, Fisheries
Roy Schumacher	Conservation Aid, Fisheries
Austin Wild	Conservation Technician, Game
Greg Mathson	Conservation Aid, Fisheries
DuWayne Gebken	Environmental Specialist
Louis George	Conservation Aid, Fisheries
James Holzer	Assistant Area Fish Manager

This project was partially financed with federal funds under Public Law 88-309, Commercial Fisheries Act as Project 3-133-R.